MACHINERY

May, 1910

LAYING OUT STEERING GEARS FOR AUTOMOBILES

By JOHN L. BARRA*

IN designing automobiles, the steering gear probably receives less consideration than any other equally important part of the entire car. As it is one of the most important parts of the automobile, it should, however, be theoretically investigated in order to secure the best possible results. Before entering upon this investigation, it should be thoroughly understood that the meaning of the expression "steering gear" here is not the worm and wheel with their

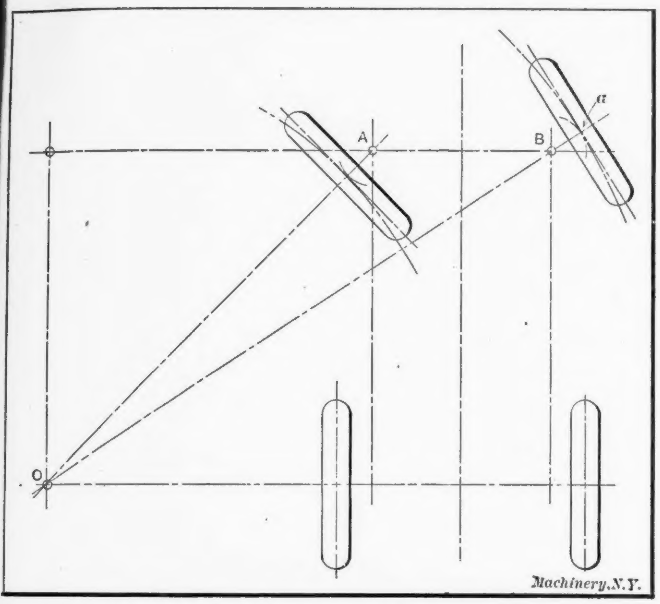

Fig. 1. Diagram showing Action of Car Wheels when turning a Curve

attachments, but the parts to which the first-mentioned is connected by means of a system of levers, that is the so-called "knuckles," which are rigidly fastened to the front wheels, and the link which joins these knuckles. This link will be called the connecting-rod.

This system of levers and knuckles, when not properly designed, will result in a stiff-steering car, and will also cause undue and excessive wear on the front tires. This comes about in the following manner:

By referring to Fig. 1, it is seen that the center of the curve or circle through which the automobile is turning is at a point O on the center line of the rear axle produced. The location of point O depends on the radius of the curve. In reality there are two concentric circles, one of radius OA, and the other of radius OB. At any point of the curve through which the car is turning, as at a, the outer wheel must be perpendicular to its radius OB to insure perfect rolling action of the wheel over the road; the inner wheel must also be perpendicular to its radius OA at the corresponding point in its path. If the wheels are not perpendicular to their corresponding radii, never-ending trouble will result. It is easily understood how sliding of either the inner or outer tire will occur with an incorrectly designed system of levers, and it is still easier to compare a sliding tire on a sandy road to one rubbing against an emery wheel.

Referring to Fig. 3, let the arms or links bc and de be called the right and left steering knuckles, respectively, and the cross-link ce, the connecting-rod. The knuckles can be made of any length desirable, usually from 5 to 8 inches between centers. Some designers contend that the point f at which the center lines of the knuckles produced intersect the center line of the car should be at the center of the rear axle. On the contrary, so simple a rule cannot be formulated.

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Fig. 2 shows the layout for the derivation of the formulas to be used. Throughout the rest of this discussion we shall observe the following notation:

W = wheel base,

T = distance between centers of swivel joints about which the front wheels turn,

m = the angle of the inner wheel,

n = the angle of the outer wheel.

P (Fig. 3) = the angle made by bc and de with the center line of the front axle.

The following relation exists between the angles m and n (see Fig. 2):

$$\cot m = \frac{AC}{CO}; \ \cot n = \frac{BC}{CO} \qquad (1)$$

But $BC = AC + AB$, and $AB = T$. Hence $BC = AC + T$. Substituting this value of BC in equation (1) we have:

$$\cot n = \frac{AC + T}{CO} = \frac{AC}{CO} + \frac{T}{CO}.$$

Since $CO = W$, the wheel base, we have:

$$\cot n = \frac{AC}{W} + \frac{T}{W} \text{ and } \frac{AC}{W} = \cot n - \frac{T}{W}$$

But $$\frac{AC}{W} = \cot m$$

Therefore,

$$\cot m = \cot n - \frac{T}{W} \text{ and } \cot n = \cot m + \frac{T}{W} \qquad (2)$$

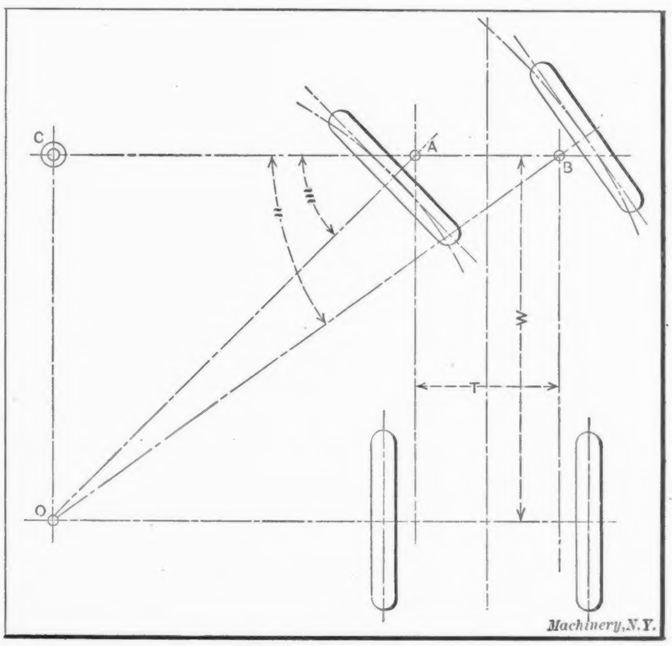

Fig. 2. Diagram giving Notation used in Formulas

From Fig. 3 we find,

$$\cot P = \frac{\frac{T}{2}}{h} = \frac{T}{2h} \qquad (3)$$

Now assume a value for h about 90 per cent of W and by equation (3) obtain the angle P. Having found P, lay out, full size, the points A and B, as indicated in Fig. 4, representing the centers of the swivel joints about which the front wheels swing, and also the angle P of the steering knuckles. Then with any convenient radius, describe two arcs from A

and B as centers and divide the left-hand arc of what will be called the inner wheel, into about nine 5-degree spaces, representing the conditions found in actual service. The length of the connecting-rod or cross-link will be DE.

With a beam compass set to the length DE and with a, b, c, etc., as successive centers, mark the points 1, 2, 3, etc., on the arc through E. Connect the points 1, 2, 3, etc., with the center B and using a protractor, scale the angles $EB1$, $EB2$, $EB3$, etc., and tabulate them under the heading "Angle of Outer Wheel by Trial" in the table, Fig. 6.

It is now necessary to see how nearly correct these trial angles are. The theoretical values of the correct angles of the outer wheel are obtained by equation (2). The values of the cotangents of m the angle of the inner wheel are obtained from a table of natural cotangents. These values are tabulated in Column 2 of Fig. 6. The value of $\frac{T}{W}$ (using numerical values for T and W) is to be added to the cotangents of m as per equation (2). This sum is then tabulated under the heading cot $m + \frac{T}{W}$.

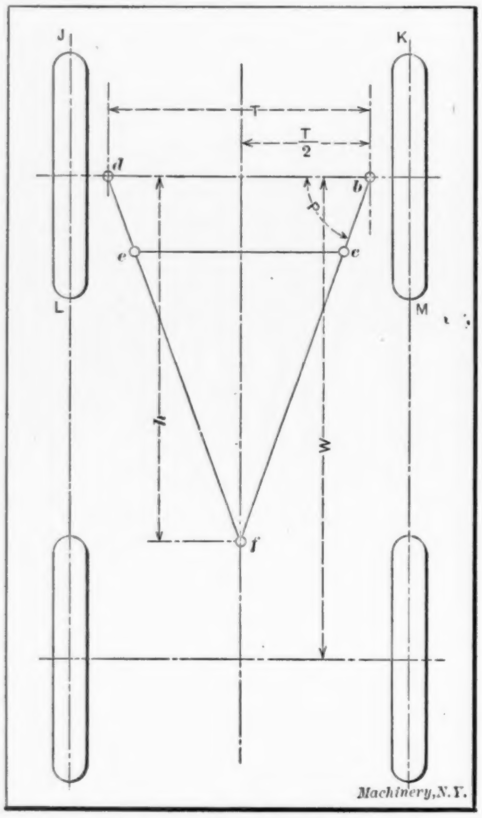

Fig. 3. Diagram for the Deduction of Formulas for Steering Gear

1	2	3	4	5	6
Angle of Inner Wheel		Values to be Added to those in Column 2	Cot. m + $\frac{T}{W}$	Angle of Outer Wheel, Theoretical	Angle of Outer Wheel, by Trial
Degrees	Cotangent				
5	11.4301	$\frac{T}{W}$			
10	5.6713	$\frac{T}{W}$			
15	3.7321	$\frac{T}{W}$			
20	2.7475	$\frac{T}{W}$			
25	2.1445	$\frac{T}{W}$			
30	1.7321	$\frac{T}{W}$			
35	1.4282	$\frac{T}{W}$			
40	1.1918	$\frac{T}{W}$			
45	1.0000	$\frac{T}{W}$			

Fig. 6. Table for comparing Tentative with Theoretically Correct Results

The angles having the value in Column 4 for cotangents are now found in a table of natural functions, and placed in Column 5.

On comparing the angles by trial with the theoretical (Column 5) angles, they will not be found to agree to any considerable extent. If the difference between the trial and the theoretical angles is very large, say from 3 to 5 degrees, it will be necessary to assume a new position of f and make a new calculation for the angle P and a new full-size lay-out. This calculation and construction is to be repeated until angles of the outer wheel are found which show a difference of not more than 2½ or 3 degrees with the theoretical angles.

When a set of angles has thus been found agreeing closely with the theoretical values, a curve can be plotted on the curve sheet Fig. 5. The curve which would give a perfect rolling to both tires is the straight line 0-0, since this line is one of no difference between the trial and theoretical angles. It is impossible ever to attain this degree of perfection in actual practice. The best that can be asked for is that the angle difference does not exceed 2½ or 3 degrees anywhere between the 0 and the 45-degree point.

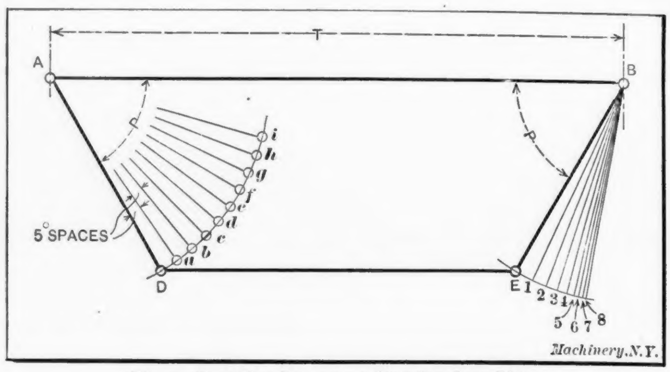

Fig. 4. Tentative Lay-out of Steering Gear Links

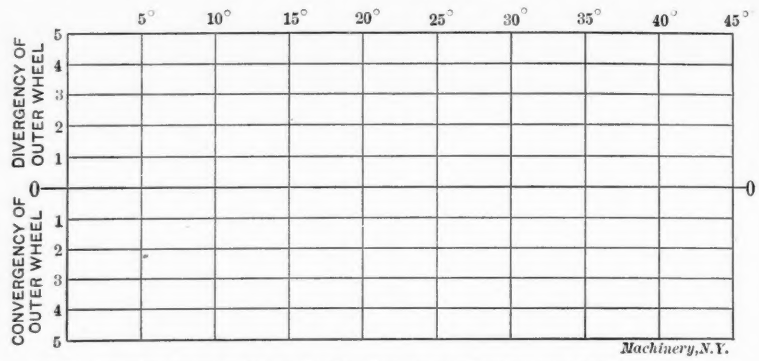

Fig. 5. Drawing-paper ruled for Laying Out Curve showing graphically Comparison between Tentative and Theoretical Angles

The horizontal spacing shows the different angles of the inner wheel, and the vertical spacing the difference between the trial and the theoretical angles. These differences for every 5 degrees are to be plotted above the base line 0-0 if the trial angles are less than the corresponding theoretical angles, and below if they are greater. If the trial angles are greater than the calculated angles, it is at once known that JK, Fig. 3, is less than the distance LM and the front wheels are convergent; on the other hand, if the trial angles are less than the calculated angles, the distance JK is greater than the distance LM, and the front wheels are divergent. In either case there will not be a perfect rolling action which will result in the car steering stiffly and cause excessive wearing of the tires.

The joints c and e should lie on the lines bf and df, respectively, and may be either ahead of the front axle or behind it.

The safest place for the knuckles and connecting-rod is just back of the front axle if it is possible to place them there. When they are placed back of the axle they are protected by the axle against accidents due to hitting rocks and stumps.

Having obtained a value of P which gives good results for the angles of the outer wheel, it now remains to design the steering knuckles and connecting rods by the methods laid down in mechanics, bearing in mind the fact that the parts are subject to quite severe shocks due to rocks and irregularities in the road, making it necessary to use a large factor of safety.

FORGING IN OLD FRANCE

By JOSEPH G. HORNER*

A smith's shop previous to 1771, taken from a French encyclopedia of that date, is shown by Plate I. It is termed the workshop of a master smith. At *d* bellows, and the rod by which they are operated, are shown. At *e* a blacksmith is urging the fire with bellows and heating the iron at the forge. The hood and chimney of the forge at *f* will be noticed. At *g* a man is occupied in filing a piece of work in the vise. Another vise is seen at *h*, both being tail vises fastened to the bench *i* exactly as they would appear to-day.

The anvils are not of exactly the same patterns as ours, and they rest on wooden blocks. There is a water bosh in front of the double forge. There is plenty of ventilation to the shop, as there are no glass windows, but hinged shutters hooked up to the ceiling which can be let down. The iron storage is seen outside. It is illustrated separately in Plate II. The bars are tied up in bundles *b* and laid against the

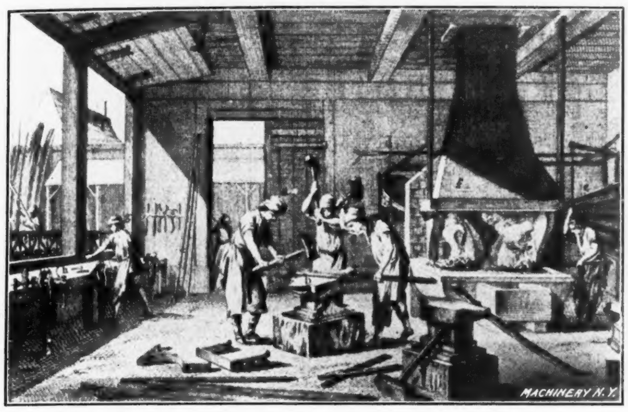

Plate I. A French Blacksmith Shop about 1770

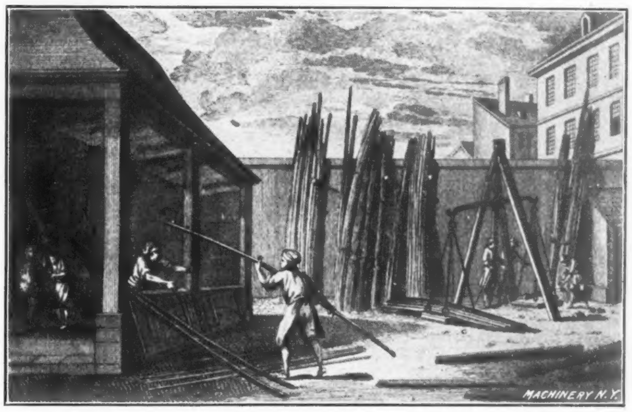

Plate II. Stock Storage and Scales for Weighing the Material

wall, and a large pair of scales suspended from a wooden tripod has bars in one pan being weighted by the two workmen. One man is passing bars into the shop, which are being taken charge of by another workman within.

Plate III shows trusses or bundles of iron bars tied up by iron rods *A*. Figs. 3, 4 and 5 show round, flat and square bars as used by the blacksmith of that time, and Figs. 6 and 7

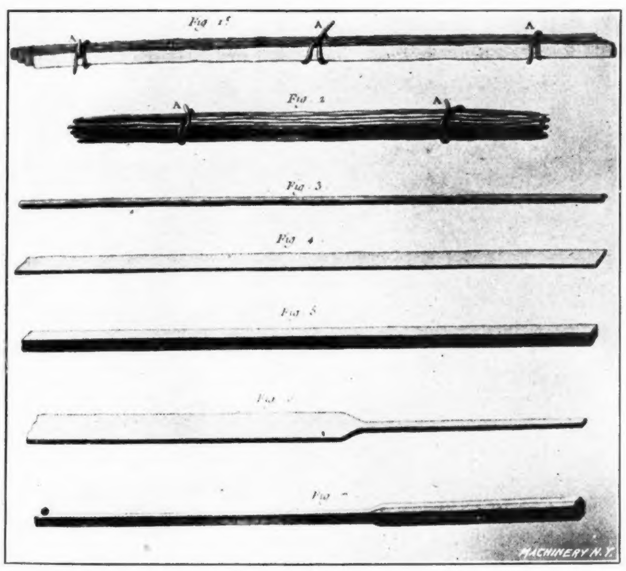

Plate III. Rough Stock and Forged Bars used in Blacksmithing 150 years ago

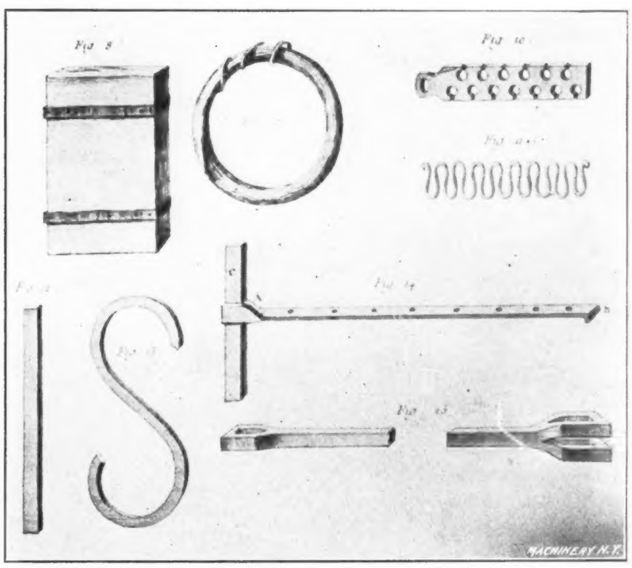

Plate IV. Materials and Tools used in Early Blacksmithing

show forged bars. In Plate IV are shown a packet of sheet iron and a coil of iron wire. A curious bar gage is seen in Fig. 10, similar to a modern wire gage with notches terminating in round holes down both sides of the gage. Another gage, Fig. 11, is formed by bending a bar in S-fashion, which is suggestive of a spring. Illustrations are given in this plate of forgings termed anchors, apparently used for building purposes; Fig. 12 is a "straight" anchor, Fig. 13 a "finished" anchor. Fig. 14 is a drawing strap, *C* being the anchor. Fig. 15 is a forging with a forked end.

In Plate V another smith's shop is shown with several workmen engaged on various operations. At *a* a man is urging the forge bellows; at *b* another is manipulating a forging of an anvil, turning, and turning it about on the four faces; the one at *c* is placing a piece on for welding, on which the men at *d* and *e* are hammering. The man at *f* is cutting a file.

In Plate VI, Fig. 1 is the "mass" from which the body of the anvil is to be made, seen again at *A* in Fig. 2. Into a square hole in it a bar *B* is fitted, to be manipulated by the cylinder of wood *C*, shown again separately in Fig. 4, and bonded at *A* with iron hoops. Holes at *B* receive the handle bar, Fig. 5, by which it is turned about. Fig. 6 shows at *A* the piece to be welded, *B* being its porter bar. In Fig. 7 the top *B* is seen welded on the body *A*. Fig. 8 shows a beak *A* prepared for welding with a porter bar *B*, and Fig. 9 is the same in place. In Fig. 10 both beaks are welded on. Figs. 11 and 12 show the steel face and the body of the anvil separately, and Fig. 14 is the finished article.

In Plate VII the making of a stake is shown, beginning with Fig. 1. In Fig. 2 the collar *B* is fitted, shown separately in Fig. 3, and welded in Fig. 5; the end *B* is then upset. In Fig. 6 one of the horns in Fig. 7 has been welded on. Fig. 8 is the steel face with its porter. In Fig. 9 the stake is complete. Figs. 10 to 17 represent the stakes in the making of a hammer, Figs. 11 and 14 being the steel jaws hatched up for welding. The next group of Figs., 18 to 20, illustrate the making of a billhook. Figs. 21 to 32 are other examples of forging.

Die forging was practiced in the eighteenth century in a small way, and the practice was the forerunner of the die forging applied to the manufacture of pistols in America, and of locks in the Black Country. Several dies are illustrated in Plate VIII for the work of making sliding bolts for doors and other purposes, which figured more largely then than they do in these days of cheap locks. The stamps were laid upon

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the anvil and held securely. Fig. 1 is a die for imparting a truly cylindrical form to round rods for window bolts, *A* being the stamps, and *B* the horns or ears. One of molded section is seen in Fig. 2, and the same is clamped to the anvil in Fig. 3. It is secured with a bridle and key. The bridle holds in the ears *B* of Fig. 2 and is shown separately in Fig. 4, and its key in Fig. 5. Figs. 6, 7 and 8 are other forms of dies; Fig. 6 is for a collar; Fig. 7 combines two recesses, one for plain bar, the other as in Fig. 8 for a molding. Fig. 9 is another kind of stamp for forging the portion *A* in Fig. 10. Figs. 12 and 13 are two stages of nail making for window bolts, Fig. 12 showing the nail blank ready for stamping, and

Plate V. Another Early Blacksmith Shop

Fig. 13 being the same taken out finished from the stamp in Fig. 14. Fig. 15 is a key for turning the nuts of bolts, *A* being the fork and *B* the handle. Fig. 16 is a tool for stamping nuts, and Fig. 17 is the same reversed showing the end by which the stamping is done. Half a dozen nuts are shown being stamped from a piece of flat bar in Fig. 18. Figs. 19, 20 and 21 are top stamps with handles. They are of the same type as those used in any smithy to-day.

Figs. 22 to 26 show separate stages in a piece of work. Fig. 22 is the first heat taken on the bar *A*, in which rings 23 or 24 are welded round a plain bar. In Fig. 25 a groove has been fullered round at *A*, and in Fig. 26 the molded sections at *A* have been finished in a third heat. In Fig. 27 a piece *A* for the ward of a key is welded on a shank, the piece being seen at Fig. 28. At a second heat the ward is flattened as in Fig. 29 at *A*. In Fig. 31 a wrist or boss *A* has been welded to the rod *B*. The wrist is seen in Fig. 30, and horns *A* are

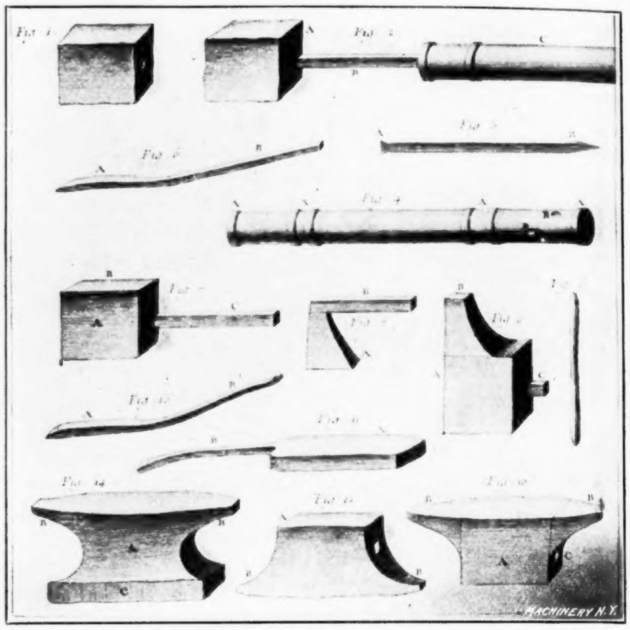


Plate VI. Successive Stages in the Forging of an Anvil

shown to enable it to hold during the welding. In Fig. 32 a piece of drawing down is shown, the drawn-down portion being afterwards bent to form the elbow *A* in Fig. 33.

How microscopic are the differences between the tools shown in Plate IX and those of a modern smithy! There is

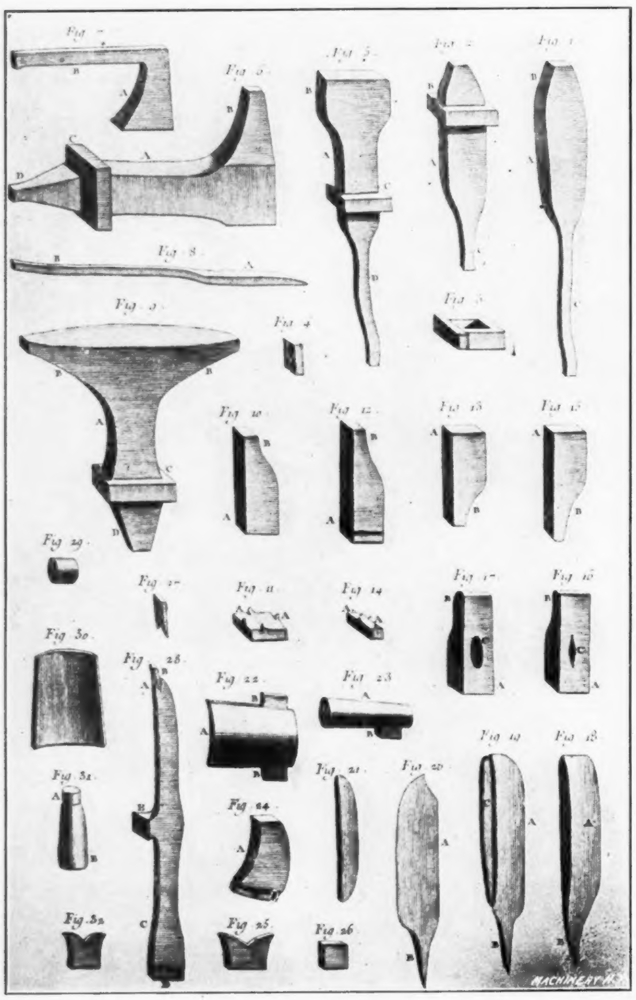


Plate VII. Examples of Forging Methods in Early Days

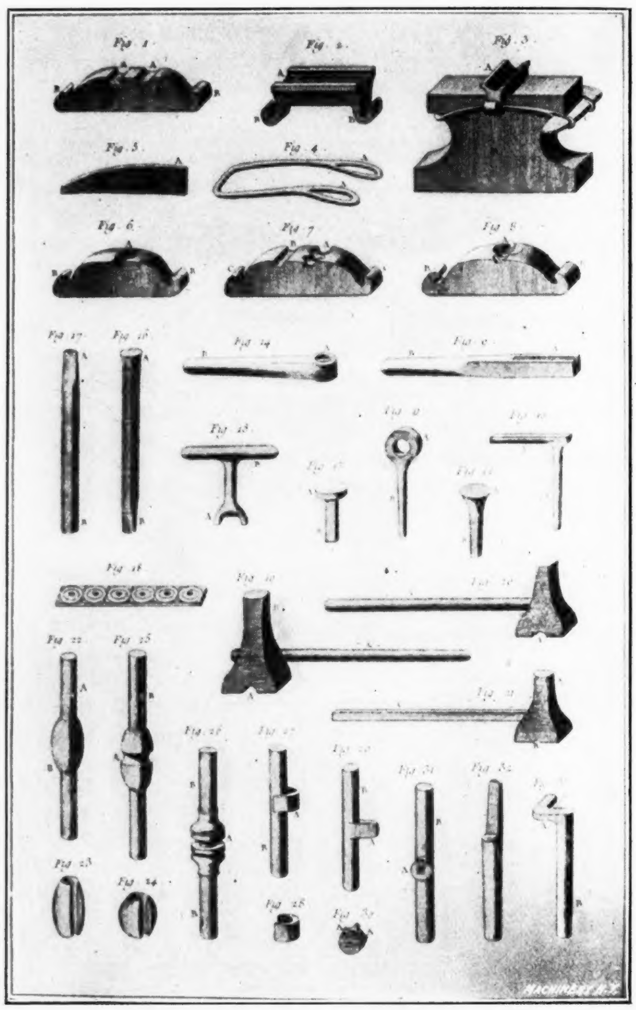


Plate VIII. Early Die Forging Tools and Methods

little need to particularize. The poker, the brush, the anvils and stakes, are nearly identical. The foot of the anvil, Fig. 4, looks rather odd, being shaped into steps, and so do the grooves at the side. A stake or little anvil is shown in Fig. 5, B being the round beak and C the square one, placed on a block or billet of wood E, bonded at F. Fig. 6 is another small stake. Fig. 7 is a scroll, finished, and lying on a block of wood. An anvil stake is seen in Fig. 10, and hot and cold

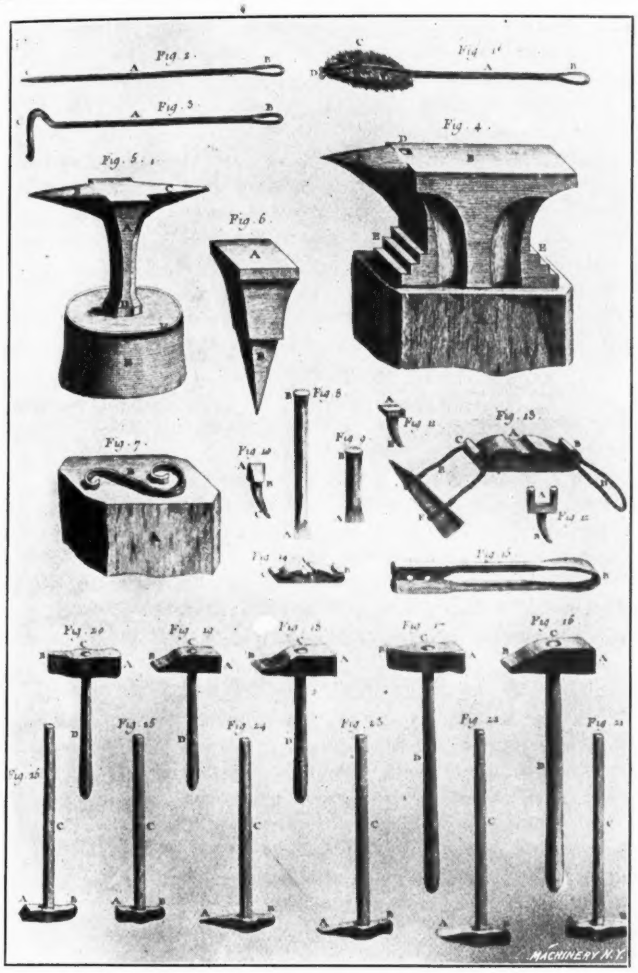


Plate IX. Blacksmith Tools of a Century and a Half ago

chisels in Figs. 8 and 9. Fig. 12 is termed a claw for a vise, probably for bending bars. Figs. 13 and 14 show more bottom dies, and Fig. 15 a spring swage. The group of hammers and sets call for no comment, being identical in form and in function with modern types.

There are some interesting examples of forged work on tools in Plate X. Fig. 1 is termed a simple anvil, and Fig. 2 an anvil with beaks, one, A, round, the other, B, square. Fig. 3 is simply a plate or block of iron. Figs. 5 and 17 are small and large gimlets respectively. Figs. 4 and 6 are instruments for working slate, 4 being for cutting, while 6 is a slate hammer. Fig. 7 is a cutting hammer. Next follows a succession of hammers, Figs. 8 to 16, the forms of most of which are familiar. Figs. 18 and 19 are chisels for file cutting. Figs. 20 and 21 show other forms of chisels, and Fig. 22 a gouge. Fig. 23 is an auger. Fig. 24 is evidently the parent of our center bit, but it is termed a *percoir à vin*, apparently meaning that it was used for boring wine casks. Next is the brace, Fig. 25. Then we come to a group of vises, jaws, or clamps, Figs. 26 to 29, the last two being for wire. Figs. 30 to 33 are smith's tongs, the forms of which are familiar.

* * *

The Krupp Works at Essen in Germany are constantly increasing in size. The number of men employed by the company at its works in Essen and elsewhere increased during 1909 by nearly 4,000, so that at the end of 1909 about 67,000 men were in the employ of the company. At the Essen works a total horsepower of over 73,000 is used, this power operating over 7,000 separate machine tools, over 900 cranes, 187 trip hammers, and 81 hydraulic presses.

FRICTION OF WATER IN PIPES

A writer in *Power and the Engineer* gives the following formula for the loss of head in water pipes, due to friction:

$$H = \frac{LQ^2}{1{,}000{,}000\,KD^5}$$

in which H = frictional head (or loss of head by friction) in feet,

Q = gallons of water per hour,

L = length of pipe in feet,

D = diameter of pipe in inches,

K = a variable coefficient, tabulated below for various diameters.

D	K	D	K
0.5	1.27	4	3.05
0.75	1.63	6	3.26
1.0	1.90	8	3.38
2.0	2.57	10	3.46
2.0	2.85	12	3.51

These coefficients apply specifically to new cast-iron pipes.

* * *

The first regular air navigation service in Europe will be begun May 15. Regular trips will be made from Munich, Bavaria, alternately to Starnberg and Oberammergau. A dirigible balloon of the Parseval type, having a gas capacity of 6,700 cubic meters and driven by two motors of 100 horsepower each, will be used. The aerial carriage will accommodate twelve passengers besides the crew. The fare for the round trip to Starnberg will be $55, and for the round trip to Oberammergau $175. The regular service will close for the season September 1. An officer from the German Aeronautic Corps has been detailed to serve as captain of the dirigible.

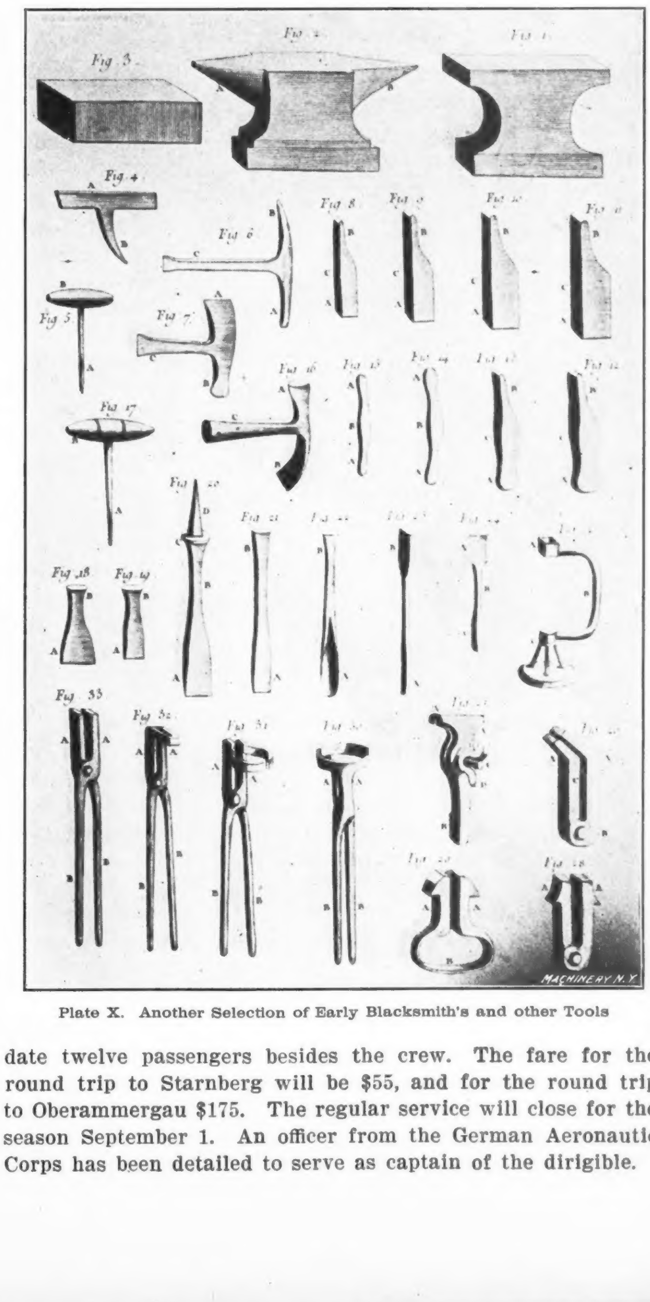


Plate X. Another Selection of Early Blacksmith's and other Tools

REORGANIZING A RUN-DOWN ASSEMBLING DEPARTMENT*—1

By ALFRED SPANGENBERG†

The present-day enthusiasm for increasing production by the use of ultra high-speed steels and by methods for "cutting time between cuts," has resulted in a disproportionate amount of attention being given to the problem of machine work in comparison with the no less important problem of assembling. Yet an investigation of the conditions existing in many manufacturing establishments will reveal that obsolete methods and processes in the assembling department nullify, to a large extent, the savings thus made in machining. The adoption of up-to-date methods of assembling may easily be expected to increase the efficiency of the average assembling department from 100 to 150 per cent, and if the department is in a run-down condition, even greater savings may be anticipated. Of course, to expect such large increases in all cases would be unreasonable, but there are many instances where such results are possible.

RECEIVED OF

____________________ Foreman.

on Machine ________ Lot ________ S. O.

No. Pieces	Name of Piece	Piece No.	Sent to	Date	Punch Here	
					Insp.	Dept.

Fig. 1. Transfer Card

While the need for system in the assembling department is becoming more widely recognized, there are many manufacturers to whom the word "system" is indissolubly linked with "red tape." "Organization" is not their idea of economical management, because it means additional "non-producers"; and the leaks continue unchecked until some well-organized competitor forces the condition to their startled attention. This condition, however, is generally due to lack of sufficient experience or data enabling a concern to determine, with any degree of accuracy, whether or not economical results are secured from foremen, workmen, or processes.

It should be fully understood that there is no infallible system which will fit all cases alike; methods must be suited to the circumstances under consideration, since the first thought in regard to any plan must relate to its adaptability to existing needs. The reorganizer can rely but to a small extent upon any established system, and his initiative and common sense must bring a working result from a mass of conflicting conditions. With these facts in mind, the author will not attempt to describe any particular system, but will only consider certain fundamental principles.

Necessity for Analysis of Existing Conditions

Before introducing innovations in a department, it is necessary to analyze existing conditions and methods with regard to the men in the present organization, for invariably a certain amount of ignorance, prejudice, false pride, and stubbornness must be met and overcome. To win success, all plans must recognize, primarily, the human element of the men affected; methods should be instituted that are likely to elicit the support, develop the latent ability, and bring out the best that is in the workers. The best system in existence will not bring complete success without securing the support of the foremen and workmen. If these points are ignored, the tendency of the workers to gradually abandon methods with which they are not altogether familiar, will cause a partial failure of the system.

The most arduous and discouraging task, next to training the old men, is that of progressing along new lines and at the same time not interfering with the regular output. This can only be accomplished gradually; any attempt to suddenly rip up existing methods will not be effective. The old systems possess a momentum not easily overcome, and it therefore will take a long time to reorganize. However, when once a general line of procedure is mapped out and progress begun, there must be no lessening of effort. Everyone must be impressed with the idea that *every day* must show *some progress*, however slight.

The machine and the assembly departments are so closely connected that the introduction of new methods of assembling must begin with an investigation of the production conditions in the machine departments. This investigation will include the quality and quantity of work, whether or not provisions are made for inspection in the machine departments, methods of routing the work, what delays are encountered in getting work to the assemblers, whether the work is sent directly to the assembling department or duplicated in large quantities and kept in a store, etc. It is apparent that any defects in the processes just enumerated will have an immediate effect on the efficiency of the assembling department.

In the assembling department itself may be found faulty judgment regarding assembling methods, lost time in looking up work, hunting for tools, and running after drawings or to the stock-room for screws and pins, mistakes due to oversight, lack of proper instructions to the workmen, etc. The faults in organization and methods mentioned in this brief outline must be eradicated before any effective improvement can result.

The Stock-tracing System

Where there is constant trouble in getting out machines or repairs in a reasonable time, it usually will be found that some one or two departments are responsible for practically all of it. The first step to remedy the trouble, then, is to locate it. The assembling department usually is blamed, but an investigation will generally reveal that the difficulty lies in not getting work promptly to the assemblers. Many manufacturers are so accustomed to delays in getting finished parts to the assemblers that they regard the matter as unavoidable, even though the consequent losses show clearly that a remedy is imperative. A well-organized stock-tracing system is an important factor in overcoming this defect, and is so necessary that a brief outline of it is deemed advisable.

INSPECTOR'S REPORT TO CHIEF INSPECTOR
ON DEFECTIVE WORK AND MATERIAL

Supplementary to Report No. ____ Date ________ 19__

Quantity ________ Inspector ____________

Article __________________ No. ____

Pattern or Forging No. ______ Dwg. No. & Part ____ Mat'l ____

From ____________ Recd. on Req. No. ____

Location ______ Dept. For Ship. on Req. No. ______

Defects, etc. ____________________

Oper. Done ________ Date Corrected ______ 19__

Fault of ________ Employed in ________ Dept.

Fig. 2. Inspector's Report from which the Monthly Report is made

The functions of a stock-tracing system are: Directing the transportation of all parts in the factory; pushing the work through the foundry and machine departments in such a manner as to prevent delays to the assemblers; keeping up records that will show the location of parts in the foundry and shop, the time required by the various departments, the labor cost, and all losses, with proper explanations. The sole authority and responsibility for this work should be vested in the head of the stock-tracing department. It is obvious to the experienced shop manager that such duties cannot be left to

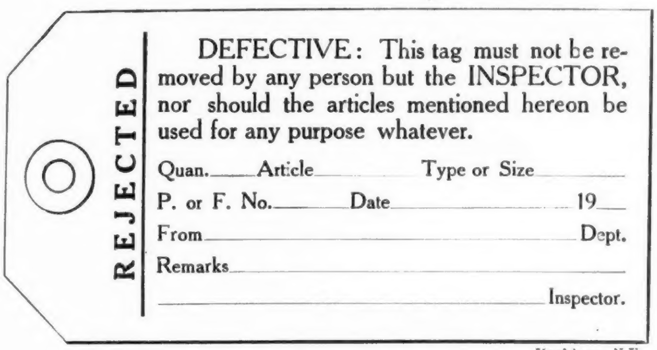
* For additional information on the subject of assembling, see MACHINERY, February, 1910, "Laying Out and Aligning Operations on Machine Tools," and other articles there referred to. See also MACHINERY'S Reference Series, Nos. 50 and 51, "Principles and Practice of Assembling Machine Tools."

† Address: 951 W. 5th St., Plainfield, N. J.—See biographical note in MACHINERY, April, 1909.

the department foremen if the shop is to be run advantageously. The foremen's attention should be concentrated solely upon improving their methods and their output, and their duties should be confined strictly to their own departments.

Experience has demonstrated that it is necessary to give the stock tracer *absolute control* of all parts in the process of manufacture; in addition, he should be given such authority that the foremen will understand that his requests for stock must be complied with under all circumstances, and he alone should have authority to secure parts from any department in the factory, either for any foreman, or for the assembling department. Having under his charge all the records for stock in the course of manufacture will enable him to locate all stock with certainty and dispatch. Another advantage is that the superintendent always knows where to get any information regarding the location of work in the factory, and the time it may be expected to reach the assembling department.

If the work is allowed to remain in any department after



Machinery,N.Y.

Fig. 3. Card or Tag for Rejected Work or Material

it is finished, it is apt to be forgotten, and is hard to find when wanted. Therefore, the advantages of having the work placed in central depots as soon as finished by each department, will amply compensate for the time consumed in hauling the work to one of the depots, putting it on a platform, checking it up and then taking it to the next department. This plan is especially advantageous where any system of inspection is followed; no stock can be lost; each foreman can see at a glance how much work there is ahead of him; and it aids the superintendent in getting a conception of the conditions of the work. The central depots can be located at any number of points and should contain suitable platforms for the storage of stock. These remarks apply, of course, to the smaller parts; it would not be practicable to carry out this scheme in the case of large work.

Transfer cards showing delivery of work from one department to another form a ready record which shows the date on which the articles have been received, the length of time they were retained, and the date they were passed on to the next department. A glance over this record shows if the work is pushed through with all the promptness possible. The question of giving certain orders priority over others is one upon which the stock tracer will need to exercise his best judgment. If any work is behind time, the card made out when the order was first sent to the shop is called in and replaced by a similar card of bright red color containing exactly the same information, and also the required date of delivery. An order with the red card always has precedence over those with cards of the ordinary color. Care must be taken, however, not to use these "rush" cards to such an extent that they become so familiar as to be ignored. A transfer card and the information it should contain is shown in Fig. 1.

Instead of allowing each foreman to have his own gang of truckers, the trucking force throughout the factory should be centralized and placed under the supervision of the stock tracer. This force of men will deliver work to all departments in the factory as it is called for, and upon their returning to the respective depots they will bring in the work that is on the machine room floors already finished. The fact that this work is finished is indicated by "Move It" cards, which are placed in the boxes by the workmen. These remarks apply to the handling of small parts; in handling large work, cranes are almost universally used.

Inspection

In a previous article appearing in the September, 1909, issue of MACHINERY, the writer emphasized the necessity for inspection of work in the machine departments in order to secure economical assembling. This is one of the essential preliminary steps in the revival of a run-down assembling department; yet it is difficult to convince the average manufacturer that it will pay to employ a number of high-priced men to do nothing but inspect the work done by other men. The idea is prevalent that the payroll for these inspectors, who are non-producers, is but a constant expense, and it is hard to realize the very large economies which their work, if efficient, will bring. The advantages to be gained by an efficient inspection department may be given thus:

1. Imperfect parts are eliminated before the work reaches the assemblers. If the parts come to the assemblers properly inspected, so that they can be put together without unnecessary filing and fitting, the saving of time in assembling easily may reach from 60 to 75 per cent.
2. The fact that the parts are interchangeable will result not only in ease of assembling, but in case of repairs the parts can be sent out with the assurance that they will fit properly without adjustment. The last-named feature is important in that it is a splendid advertisement to any concern.
3. It instills into the minds of the workmen the fact that the work they produce must be up to a high standard, and that if it be otherwise it will be thrown out, at their loss. This one feature will result in marked improvement in the quality of the work.
4. The workmen receive pay for good work only and are charged with that which is defective, so that an inspection system provides protection to the company.
5. The elimination of defective parts by an inspector, important as it is, is only of minor significance when compared to the general effect. It would astonish the average manufacturer to find how soon his workmen will come up to any standard set by the inspection department, and how small the loss will be, no matter how close the limits are held.

Any system of inspection must be thorough, and the limits given to the work must be adhered to uncompromisingly. Weakness on the part of the inspector will immediately be noted by the workmen. The inspector's authority to reject work should be unquestioned, and the superintendent should never, unless when absolutely necessary, reverse his decision. An inspector should be placed upon as high a plane as any of the foremen in the factory, and to be successful, he should possess good judgment, firmness of character, and familiarity with the business.

A thorough system of inspection effects large economies in every direction, but principally in the assembling department. The parts can be assembled more quickly and accurately, and the saving in this department alone will pay for the cost of inspection. Besides, the machines built will be much more accurate. In many cases it is not necessary to establish a very elaborate system.

There is another phase of this question which is important from an economic standpoint; this relates to fair and consistent inspection—*commercial* inspection. Unless an inspector has sufficient intelligence to discriminate between vital and unimportant dimensions, and unless he possesses enough judgment to know when a job is commercially satisfactory, he causes a waste of time and imposes unnecessary hardships on the men who do the work. Good judgment in inspection is a vital factor, and it will pay to employ first-class men on this work. The best workmen and machines sometimes make a slip as to size, and to ruthlessly reject work which is commercially satisfactory is an abuse of the inspector's authority. An inspector is apt to forget that on the large majority of work there is often no necessity for anything closer than a few thousandths inch. Therefore, it is advisable, in many instances, to have limit gages with as wide limits as the character of the work will permit, and to have rejected work looked over by a chief inspector whose decision is final.

Reports should be made by the inspectors at least once a month, showing the amount of work scrapped by each department, together with the reasons. The effect of this upon the foremen is marked; when they realize that they are liable to censure for the excessive amount of scrap coming from their departments, they will soon give the matter their per-

sonal attention. Fig. 2 shows a blank report of this character, while Fig. 3 shows a card or tag which is placed on all defective work by the inspector. A simple system of this kind, tried for a few weeks, will prove to any manufacturer that the unecessary waste in his factory is astonishing.

Having thus analyzed general factory conditions, attention will now be given to the methods for increasing the efficiency of a run-down assembling department. The causes of loss should be clearly recognized and logically grouped for study. This will enable us to easily see what must be done (and what *must not be done*) to secure improvements. The sources of waste already referred to may be classified as follows:

1. Defects of departmental organization—of the foremen, the job bosses, and the usual methods of management.
2. Defects of assembling systems.

1. DEFECTS OF DEPARTMENTAL ORGANIZATION

The Foreman

The first and the absolute requirement for an efficient assembling department is an efficient man to run it. No half-baked "graduate" of the existing department will bring proper results; this department calls for a man of a high type. This cannot be emphasized too strongly, for it is foolish to plan a campaign of improvement with any expectation of success unless this first step is taken. The mistakes and shortcomings of the low-priced foreman are too costly; a well paid, progressive man is the cheapest in the end. He should have a thorough knowledge of the most economical methods and of the special labor-saving devices, jigs, etc., best adapted to the work he handles, and, last but not least, the ability to handle men tactfully.

In selecting the foreman, it should always be remembered that he is to the workmen the direct representative of the firm, and that the men base their opinion of the company largely upon their opinion of the foreman; hence, the personality of the foreman affects the workmen more directly than any other factor in the shop organization, and has a direct effect upon their efficiency and disposition toward the company. The foreman must be invested with absolute authority over his men, and he should be given "his chance," which with most men means increased ability to handle the problems submitted to them. Of course, the foreman of a department should consult frequently with the superintendent regarding any important problems that arise, for it is well to observe the principle that, nine times out of ten, the joint advice of several men is superior to any plan developed from one man's brain. It frequently happens, however, that a superintendent makes the serious mistake of ignoring the vital points just mentioned, and instead of entrusting the details of the work to his foreman, gives orders directly to the workmen; in this way the workmen gradually lose respect for their foreman, and the latter becomes a mere figure-head, without any authority except in minor details.

Owing to the weakness of the ordinary foreman, the majority of up-to-date concerns have adopted the broad policy of instituting a rate-making department, and jig-designing and jig-making departments, entirely independent of the foremen. The principal reason for the adoption of this plan, however, is the fact that a foreman seldom has time to set piece-work rates, design jigs, etc., and attend to the other important duties that demand his attention. As has already been pointed out, the foreman's entire energies should be concentrated, as far as possible, upon the important duties of supervising the work and devising ways and means for increasing the efficiency of his department.

The Job Bosses and Workmen

It is evident that a foreman cannot properly oversee his entire department without assistance and still devote his attention to the larger and more important details of his work. The usual method of procedure in order that each man or group of men may receive the proper amount of attention, is to appoint the more efficient members of the working force to the position of "job bosses." Each job boss is invested with a limited degree of authority over a small group of men, and, by performing his share of the work in addition, receives a slight increase in pay. These men should be carefully selected, since they usually are next in line for advancement to assistant foremanship.

When the department is sufficiently large, the foreman should be relieved of all clerical labor such as making out time-cards, writing sub-contracts, checking up parts received, etc.; and this, of course, presupposes the employment of one or more clerks.

As a general proposition, first-class, well-paid machinists are the cheapest in the end on assembling work. This is especially true where the work varies in character. The amount of work that will be turned out by a highly skilled assembler, when compared to that of a cheap man, is astounding. An important feature to consider is also the fact that the workmen's pay is only one part of the total cost, because a largely increased production per square foot of floor area decreases the proportion of overhead cost per piece.

Where work is duplicated in large quantities, so that there are constant repetitive processes, it is possible to so train the cheaper and less experienced workmen that they in time become expert on their particular class of work. It is advisable to provide for a rigid subdivision of labor. Thus, the more particular work at the vise or bench is handled by special men who do no other class of work. These high-priced mechanics perform no work that can be done by cheaper men or apprentices, and in this way, the average rate is kept normal.

Systems of Pay and their Effect Upon the Workmen

The system of pay is one of the most important elements to be considered in the case of a run-down assembling department, because assembling work is progressing only when the workman is busy. In order, then, to stimulate production, it is absolutely necessary to offer a reward for extra efforts on the part of both the foreman and workmen. To give the foreman all the gains is manifestly unfair, and leads to dissatisfaction on the part of the workmen; in fact, an inequitable system of pay invariably causes a lack of proper results and seriously affects the cost of assembling.

The piece-work system is the one usually in vogue, but its chief evil lies in the universal practice of cutting rates when the men begin to earn large wages. This trouble is very largely caused by the practice of setting "original prices," or "original times" not based upon data mathematically determined, but either upon best previous records, an ordinary "try-out," or, worst of all, on the cost department's estimate. The workmen find that their only protection from reduction in prices lies in the strict adherence to a certain limited rate of earnings and hence of production, with the result that the firm suffers unconsciously through excessive costs and limited output and the men are discontented and determined to "get even" for unfair treatment.

It is clear that it is to the advantage of the manufacturer to get the hours down to the points determined upon. When the work of determining "standard times" is accurately done, as, for instance, in shops where an expert tester is employed who analyzes the assembling operations to the last degree, the figures obtained will be so far below the results previously secured in existing shop practice, that the workmen, in all sincerity, will refuse to believe that it is possible to attain such rates of production. A flat piece rate based upon these "times" would lead to trouble, because of the lack of stimulus. It is advisable, therefore, to offer an extra reward to the workman attaining standard time, with the guarantee that no reduction will be made unless methods be changed.

The attainment of standard time, however advantageous, will never be realized unless the assembling department is so arranged and equipped that the same conditions prevail in everyday manufacture that existed when the expert tests were made. This is a point that is often overlooked. The particular benefits derived from having an expert tester, lie not only in the accuracy with which prices can be determined, but also in that the firm is enabled to show the workmen, by actual demonstration, that the work *can be accomplished* in the time set for it.

The systems of pay in general use are as follows:

The Day Work Plan.—This plan is decidedly inefficient unless the men are rigidly supervised, or under special conditions where the work is intricate and exacting.

Piece-work.—By this the workman receives a certain amount of pay per piece. One of the greatest objections to this plan, as already stated, is that it is so often coupled with the practice of cutting rates when the men begin to earn large wages.

The Premium Plan.—This is a very efficient system of pay on many classes of work. The determination of "standard times," however, should be made carefully, for if the rates are set by incorrect methods, it is easy to imagine the results that will follow. In fact, the determination of "standard times" on assembling work is a particularly difficult proposition, since the skilled assembler can and will deceive anyone not of the highest order of expertness concerning his possible rate of production, particularly when he has worked for years on repetitive processes and thereby has gained marvelous skill. Consequently, in order to secure an extra output, the possibility of which lies concealed within the workman's skill, it is absolutely necessary that the premium be sufficiently large to stimulate his ambition.

The Bonus Plan.—This is a system of task work combined with the use of instruction cards for the workmen and a bonus for accomplishing the task within the time set for it. This plan readily lends itself to adoption in case the men already are working on the day work basis. It also has the advantage of being introduced with little opposition, because it is easily understood by the workmen; and, besides, it is adaptable in some form to almost any other system of pay already in existence in the shop. To be effective, however, it should be combined with methods that accurately determine the shortest time in which a job can be accomplished; and it also should include provision for the job bosses and foreman securing bonuses in case all the men under them earn bonuses. This will compel the foreman to immediately give his close attention to the inefficient workman for his proper and speedy training or his discharge.

This bonus system of pay has always appealed to the writer as the most effective of all systems yet devised for assembling work. But it should be remembered by anyone contemplating the adoption of a piece-work or bonus system, that in addition, it is absolutely necessary to provide a check upon the workmen in the form of an inspection system, for if this point is neglected, the quality of the work will suffer.

THE BATEMAN PLANER DRIVE

By JOSEPH G. HORNER*

During recent years some very excellent designs of planing machines with cushioned reversals to the table have been built in England. Messrs. Bateman's Machine Tool Co., Ltd., of Leeds, whose machines are in the front rank, have been introducing a separate self-contained driving apparatus to be fitted to old designs of machines, both for speeding them up and cushioning the reversals. They term it "plano-drive," and a cushioning device is introduced in the form of a spring wheel, which in effect corresponds with the sliding spring rack which is used on the firm's planing machine tables. The mechanism comprises driving pulleys carried at the head of a tall steel framing for belting from the countershaft and to the pulleys below which actuate the firm's flywheel drive, spring wheels, and a complete set of gears for operating the planer table. All the existing gears on the machine to be speeded up are taken out, connection being made directly from the "plano-drive" to the last driving shaft of the planer through a flanged coupling, or bevel gears. In some cases a motor is substituted for belt pulleys from the lineshaft, in which case it is coupled direct to the countershaft, special frames being fitted to the sides of the plano-drive to carry it. Several firms who have had their planers speeded up have taken the opportunity also to electrify them. In many cases the cutting capacity of the machines has been much more than doubled by the adoption of this drive.

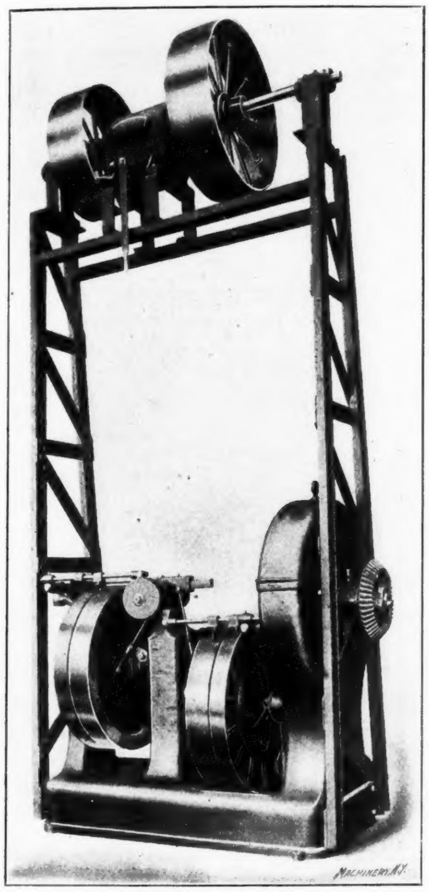


Fig. 1. Bateman's Planer Drive

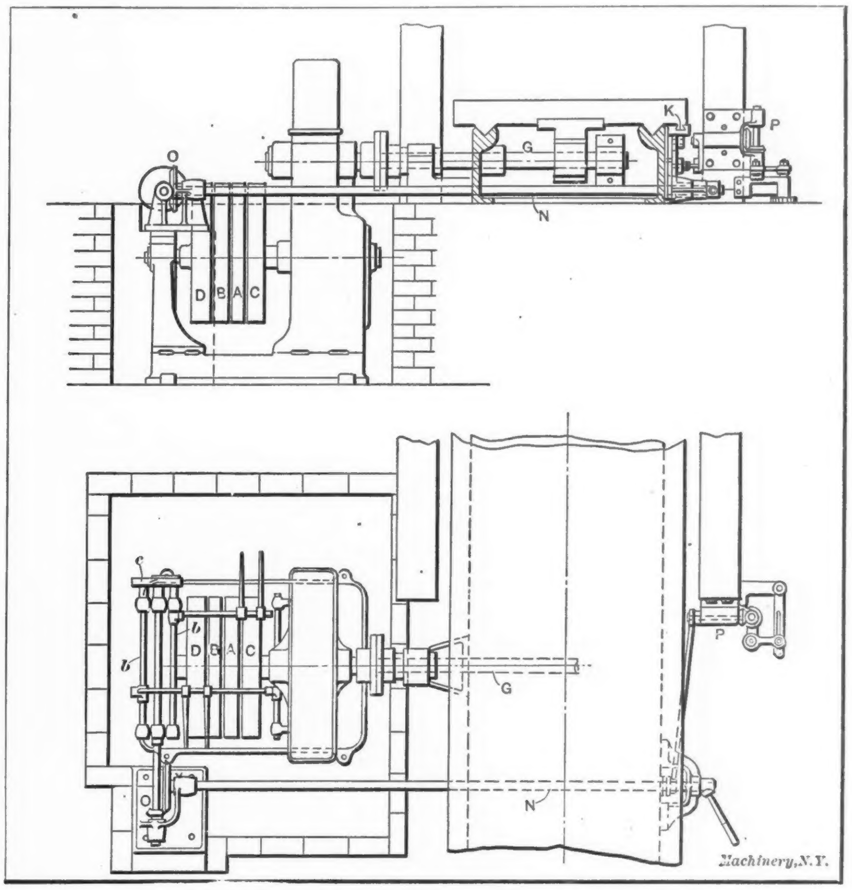


Fig. 2. The Bateman Planer Drive applied to a 4-foot, 6-inch Planer

Figs. 2 and 3 illustrate the details of the plano-drive coupled to a 4-foot 6-inch planer. The plano-drive is placed in a pit beside the machine, coupling direct onto the bull pinion shaft, thus scrapping all the old gearing in the machine. The new gearing in the plano-drive replaces all the gearing that is taken out, and obviates all risk of breakage due to the higher speeds. Owing to the use of the spring wheel, the shock at reversal is actually less after the plano-drive is fitted than before.

In Fig. 3 the two fast pulleys for cut and return are

* Address: 45 Sydney Buildings, Bath, England.—See biographical note, MACHINERY, May, 1908.

marked respectively A and B, and their loose pulleys C and D. As the return stroke is always made at a constant speed, a pinion E is always in mesh with the large spur gear F, keyed on the short shaft that is connected by a flanged coupling to the bull pinion shaft G of the planing machine. The two cutting speeds are produced by change-speed gears mounted on two shafts H and J, these shafts being eccentric, and operated by a lever a, which, through lever connections and a rack and pinions, turns the eccentric shafts so as to bring one or the other pair of gears into engagement. Pinion E is thus driven in the reverse direction to that of pulley B.

The belt-shifting gear comprises a pair of forks for each set of pulleys, each pair being operated by a rod actuated from shafts B, Fig. 2, worked by a cam plate C, the part rotation of which has the effect of throwing the forks along in their proper relations for shifting the belts onto the fast pulleys for either cut or return. In Fig. 2 they are shown in the non-driving position, that is, both on the loose pulleys. The partial rotation of the shaft which carries C is effected by a lever d, Fig. 3, which is connected to the reversing mechanism of the planer.

The spring wheel is in course of modification, but the principle of action may be briefly described as follows: The large gear F is mounted loose upon its shaft. An oscillating lever is keyed on the shaft. Fitted inside the gear are spiral springs mounted in telescopic cases carried upon adjustable brackets; the projecting plungers butt against the end of the oscillating lever, and they are so arranged that when the machine is cutting, the thrust is taken against the solid metal of the spring case. When reversing, the shock is absorbed wholly by the springs. This spring wheel takes the place of the spring rack fitted in the tables of the firm's standard planing machine. (See description in MACHINERY, July, 1905). The standard flywheel pulley drive is also incorporated in the plano-drive, the flywheel pulley being at C in Fig. 3. Its endwise movement to throw it into engagement with the pulley A is effected by a lever c, worked by connections from the rods which carry the belt-forks. When the belt is shifted from C to A, C is also moved endwise to clutch it to A.

Fig. 2 shows the details of the relations of the plano-drive to the machine. In the top view the pinion and rack are shown. The reversing gear comprises two dogs, which alternately strike a "tumbler," which in turn rocks the shaft N passing through the bed. This shaft is coupled at the opposite end to bevel gears O, which operate the cam-shaft. The gear at P is for producing the automatic feeds to the planer heads, in the usual manner.

* * *

The extent to which the Walschaert valve gear, which was rarely seen in this country a few years ago, is now employed on American locomotives, is shown by the following figures: The total number of locomotives ordered during 1909 for which the Walschaert valve gear was specified was approximately 1,638; the number of those which were to be equipped with the Stephenson was 745; while the Baker-Pilliod gear was applied to about 65.

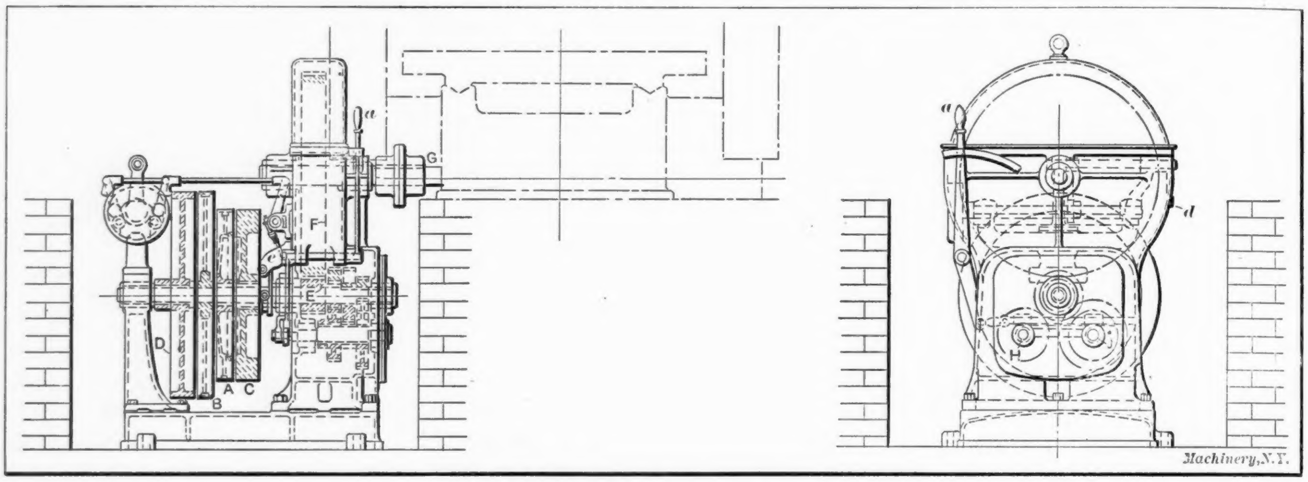


Fig. 3. General Design of the Bateman Planer Drive

METHOD OF APPLYING MOTORS TO MACHINE TOOLS

In a paper on the Economy of the Electric Drive in the Machine Shop, read at the April meeting of the American Society of Mechanical Engineers, Mr. A. L. De Leeuw reviewed the conditions which must be considered in connection with the equipment of a machine shop with electric drive. In conclusion he gave a general idea of the mode of application of motors to machine tools, the selection of motors for different classes of tools, and the lines along which economical results may be expected. The following abstract of these conclusions will undoubtedly be of interest to mechanics in general.

Bench and Speed Lathes

Bench lathes should be driven from a countershaft attached to the wall or bench and driven in turn by a motor. Any kind of motor except a series-wound or heavily compounded motor will do. The object of the motor drive is to get the machine in the best possible location without regard to the location of the lineshafting. A number of these machines may be driven by a common lineshaft, which in turn is driven by a motor.

Speed lathes should be driven from a countershaft located under the lathe, or by a direct-connected motor. In the latter case a variable-speed motor is to be preferred, if direct current is available. Motor drive is recommended when the machine is used in the assembling department, as the machines may then be placed where they are most needed; the crane service would also interfere with countershafts. There will be no material gain, if the machines are to be used for ordinary shop operations.

Engine Lathes

Various modes of driving engine lathes by motors are in use. Some makers furnish motor-driven engine lathes as standard equipment. Some have a headstock with a limited number of speeds, and depend on a variable-speed motor to fill out the speeds of the lathe. Others apply a constant-speed motor, or one with a limited amount of variation, to an all-geared headstock. In general, the use to which this class of machines is put in the shop would naturally lead to group drive. There is no material advantage in the individual motor drive, if the machines are used for regular manufacturing operations, except where the location demands individual drive.

Heavy Engine Lathes, Forge Lathes, etc.

Heavy engine lathes, and lathes of similar types should be driven by a direct-connected motor. The motor should be direct-current, as these machines are too heavy to permit a convenient all-gear drive. If no direct current is available and there is only one machine of its class in the shop, and this is used for an occasional job only, an alternating-current motor could be used, leaving a wide gap in the speeds. If these machines are used for manufacturing purposes, however, it will pay to install a small synchronous connector. The speed range in the motor does not need to exceed two to one, though a wider range is better if obtainable without complications or great expense. The position of the motor should be low, as the vibrations in the motor-support have a decided influence

on the capacity of the machine, as well as on the repair bill. The output of this class of machines may easily be increased from 20 to 25 per cent by motor drive. Further advantages of the motor drive are the possibility of placing the machine in the line of the routing of heavy work, and of placing it immediately under the traveling crane. This latter object may be reached with a belt-driven machine by placing the headstock under the gallery, if the construction of the shop lends itself to this arrangement, but the same convenience as that of the motor drive cannot be obtained.

Axle and Wheel Lathes

It is of the greatest importance that axle lathes and car and driving wheel lathes should have the highest possible efficiency, and the most convenient location. These machines are mostly used in locomotive and car repair shops, where time saved does not mean merely the saving of wages, but each day gained means an added day in the earning capacity of the engine or car. It is, therefore, important that these machines be motor-driven whenever installed in a railroad repair shop, though this does not mean that they should not be so driven if used for manufacturing. Direct current should be used. The economy of the motor drive should not be figured in increased output, but in reduction of time required to repair an engine or car.

Chucking Lathes

Generally speaking, there is little reason why a chucking lathe should be motor-driven. Most chucking lathes are provided with the necessary mechanism to shift speeds quickly. A few types handling large work may be motor-driven to advantage, though practically the only advantage lies in the fact that small gradations in speed can be thus obtained. Such machines, therefore, require a variable-speed motor.

Automatic Screw Machines

Small automatic screw machines are generally group-driven. Large machines may be individually motor-driven to good advantage. The larger sizes have generally one or two speeds for one piece of work, though these speeds may be varied when the machine is reset for a new piece of work. The speed given to the machine must naturally be proportional to the largest diameter to be turned, or in other words, to the size of stock used. This will reduce the speed for some of the operations such as drilling and reaming, far below the economical speed. The amount of time saved by the application of the variable-speed motor may be considerable. Where the construction of the machine permits, two motors, one for feed and one for speed, would give still better results. In all cases variable-speed motors should be used.

Drill Presses and Boring Machines

The only reason why the sensitive drill should be individually motor-driven is that it is often used in an assembling department, where height of ceiling and crane service would make a belt drive awkward or impossible. Most sensitive drills have, in themselves, all the speeds required for their work, so that any type of motor will be adaptable. The motor may either be directly applied to the machine or may drive a countershaft on a stand; or it may be placed on the floor by the side of the machine, in case the machine carries its own set of cones or other variable-speed device.

Generally speaking, the upright drill is used for manufacturing operations and does not require frequent changes of speed. There are, however, many exceptions, for instance, where upright drills are used to do all the operations on a piece by means of a jig. In this case frequent changes of tools, and, therefore, of speeds, are required, and an individual motor drive, whether direct-connected to the machine or operating on the countershaft, is of the greatest benefit. No great benefit can be derived from a constant-speed motor with this type of machine. Radial drills may be considered to present the same requirements as upright drills. There is an additional reason why radial drills should be motor-driven—they are often used in the neighborhood of the assembling floor.

Where the work for boring machines is specialized and the machines perform only one operation, there is no good reason why the motor drive be preferred to belt drive. Where, however, the machine is used for a multiplicity of operations, such as drilling, boring, reaming and facing, a motor drive is beneficial if a variable-speed motor is used. The range of speed of the motor should be as wide as possible, so that no gears may have to be shifted for the entire set of operations on a single hole. Especially where a boring machine is used for facing, this variable speed will be found highly economical.

Grinders

Grinders, in general, require so many various movements driven from countershafts that it is hardly possible to apply a single motor directly to the machine; the best that can be done is to attach the countershaft to the machine and drive the former from a motor standing on the floor or on a bracket attached to the machine. In isolated cases it would be well to have one or more motors, each controlling a single operation, attached directly to the machine.

Planers, Shapers, Slotters

Planers in general are not benefited by the application of a motor, as the motor only complicates the difficulties of a planer drive. However, large planers which must be placed under a crane give better results when motor-driven on account of the facility of handling the work. Another possible advantage when using a variable-speed motor and controlling the speed of the motor at the end of the stroke is that much higher return speeds can be obtained in connection with any desired cutting speed. What is true of planers is also true of shapers and slotters. Local conditions may make it advisable to drive them individually by motor, but generally speaking, there are no great advantages to be gained with this drive.

Milling Machines

The larger sizes of knee-and-column type machines, if motor-driven, will give the best results if the motor is of the variable-speed type, especially where these machines are used for gang work. This is due to the fact that the speed of the mills is dependent on the largest cutter in the gang, while the feed is dependent on the smallest cutter, not counting the limitations due to the nature of the work. It is therefore important that the speed should be as close to the permissible limit as possible. When applied to this type of milling machine, the motor should be as low down as possible, as vibrations in the machine have a marked effect on the quality of the finish. In practically all cases the planer-type of milling machine should be motor-driven, in order that it may be located under a crane. It is not so very important, however, whether the motor is of the constant-speed or variable-speed type.

Punches, Bending Rolls, Shears, etc.

This class of machinery, used largely for boiler, bridge, structural iron and ship-building work, is generally placed in high shops and under cranes, and in locations and directions most convenient for the routing of the work. The shops in which it is placed are generally large and contain a relatively small amount of machinery, so that the amount of transmission gearing required is large in proportion to the amount of machinery. It is for this reason advisable in almost all cases to drive this class of machinery by an electric motor, which, of course, does not need to be of the variable-speed type.

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ANOTHER USE FOR MOVING PICTURES

We have alluded to the importance of the moving picture industry and the educational value of pictures showing mechanical processes, methods of work, etc. The players of the game of war, who are so expert on paper and never miss a chance to utilize, in theory at least, every improvement in mechanics that can possibly be twisted to destructive purposes, have seized on moving pictures as a means of improving marksmanship. The system is quite an elaborate one and has been tried with more or less success in the British army and those of other nations of Europe. By this, men are enabled to engage in practice under conditions which nearly duplicate those of real warfare. For instance, scouts in the picture are seen to come from cover and advance, fire at intervals and return to cover just as flesh and blood sharpshooters would act. The screen which is acting as a target is quite near the real marksman, but the effect is the same as practised at 600 yards. The hits are registered automatically and at the end of his practice he is shown at a glance the record made.

BRITISH TRAVERSING-HEAD SHAPERS

By JAMES VOSE*

The British machines illustrated in Figs. 1 and 2 have been patented by John H. Storey & Co., Hatcham, London, and are built by the same company. In designing the machines, the idea has been to combine the admitted handiness of the American pillar-type machine with the rigidity of the work-carrying members of the traversing-head or generic British tool. To a considerable extent the tool illustrated embodies the features which render the "open-side" or "side" planer adapted to the machining of pieces of unwieldy and heavy character. The freely T-slotted extended base, front of machine, and table sides, allow great latitude in this respect, work being easily and securely clamped, while the reciprocating and traversing portions of the machine can be kept within a reasonable size, being at the same time of great strength.

The machine is similar to the pillar style of shaper in that the whole of the driving gear and link and return motion is enclosed in the body, is carried directly under the saddle, and traverses simultaneously. Many ordinary British machines display a tendency to twist the ram owing to the side connection of the link motion, etc. In the Storey tool this objection is obviated by the driving gear being placed under the ram, giving a central thrust and drive. The rocking arm is also enabled to be of considerable length. Shafts, spindles, etc., can be passed through the body for keywaying purposes, and the back gear is thrown in or out by an eccentric lever which is always clear of the belt at any angle. The feed can be started, stopped, or reversed, while running, and breakage due to over-running of the saddle or other excessive strain is prevented by a slipping device. The stroke of the ram is adjusted by a screw, liability to slip being eliminated, and the adjustment can be made with the machine either running or stopped. The stroke index plate is level with the ram where it can easily be seen when making adjustments. The traversing screws are fitted with graduated collars reading to 0.001 inch, the tool heads are fitted with worm and worm-wheel motion for internal curves, and a circular motion in front of the bed may also be fitted if desired.

The machines are highly geared with a view to efficient use of the latest high-speed steels. If desired, a gear box drive can be substituted for the cone and countershaft, or the machines may be motor-driven. The machines are made in

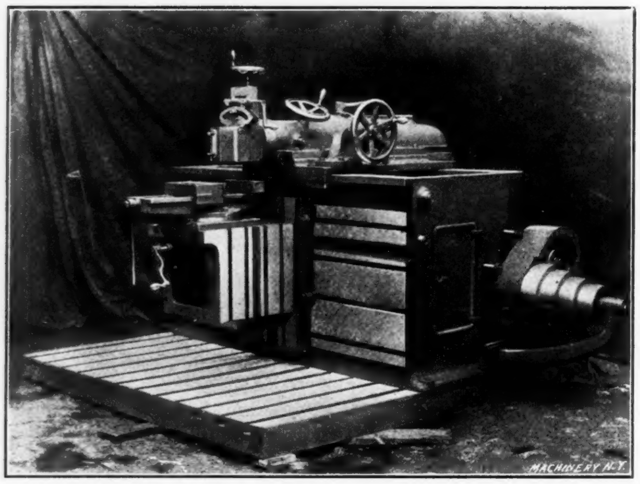

Fig. 1. Traversing-head Shaper of British Design

seven sizes from 8 to 36 inches stroke. The following details of the smallest and largest sizes of the machines will give a good idea of the capacity of the shapers generally. The 8- and 36- inch stroke machines have beds 4 and 14 feet long, respectively, the depths being 2 feet 9 inches and 4 feet. The tops of the tables are 10 x 15 and 30 x 48 inches, and the sizes of the extended bases are 4 x 2 feet and 14 feet x 4 feet 6 inches. The longitudinal traverse of the saddles is 2 feet and 10 feet. The widths of the ram bearings in the saddles are 7½ and 14 inches, and the lengths of the ram bearings are 18½ and 56 inches. The diameters of shafts which may be passed through the bodies of the 8-and 36-inch machines are 2 and 4½ inches, the number of speeds on the cone pulleys are 4 and 10, and the diameters and widths of the countershaft pulleys are 9 x 2¾ and 18 x 5 inches, the countershaft speeds being 200 and 350 in the respective machines. The horsepower required for the full duty the machines are capable of is 2½ and 20, and the weights of the machines—with fixed base and two tables—are 3,360 and 40,320 pounds, and the floor space needed 6 feet x 2 feet 6 inches and 20 x 12 feet.

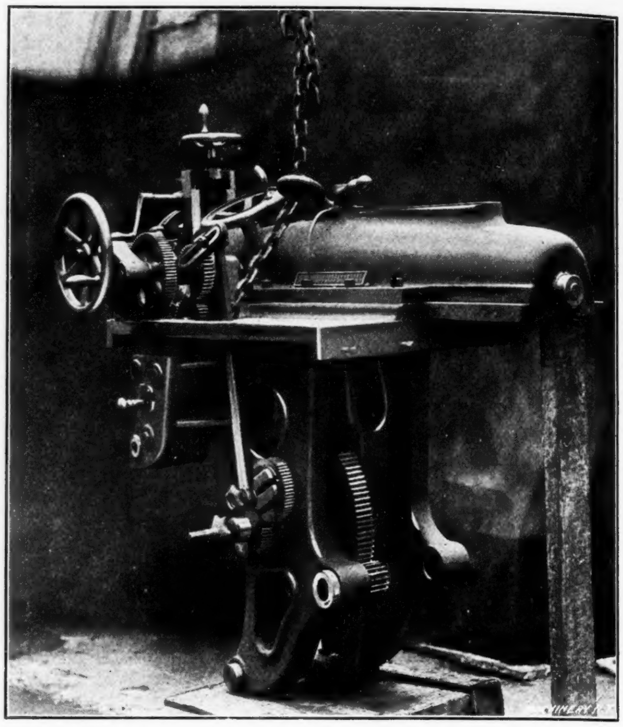

Fig. 2. Saddle, Ram and Driving Motion of British Traversing-head Shaper

It may be added that the machines are patented in various countries, and that, at the time of writing, the American and German patent rights are for disposal.

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CARBORUNDUM FOR ALUMINUM MOLDS

It is mentioned in the *Practical Engineer* (London) that carborundum on account of its remarkable thermal conductivity, has recently received an interesting application in the manufacture of molds for cooling aluminum so as to rapidly chill the cast metal. Aluminum becomes much denser when it is cast in a carborundum mold, because of this rapid cooling, and the metal surface becomes much finer. The molds, it is stated, are made in the following manner: fine carborundum powder is mixed with sugar and clay; to this mixture is then applied a sufficient amount of mortar to produce a plastic mass in which the desired mold is shaped. The mold is then baked and possesses the advantage of being permanent, lighter than metal molds and readily broken up, crushed and reduced to a fine powder, which can be used again for making new molds.

* * *

The *National Telephone Journal* gives an account of the number of telephones in the various European countries. From this it appears that on January 1, 1909, there were about 2,400,000 telephone apparatuses in use in Europe, more than one-third of which were in use in Germany. Sweden has more telephones in proportion to population than any other country in Europe, there being one telephone apparatus for each thirty-four inhabitants. Denmark, Norway, Switzerland and Germany come next on the list. It is not mentioned how many telephone apparatuses there are in the United States, but the number is estimated at about 2,000,000, which would be one apparatus for every forty or forty-five inhabitants. It is interesting to note that in Sweden, where, in proportion to the population, the telephone is most commonly used, public ownership of telephones and telegraphs is an established policy.

ACCURATE GAGE WORK IN THE BENCH LATHE

By A. L. MONRAD*

It was not very long ago that the making of a gage such as is illustrated at *A* in Fig. 1, by methods which would enable practically the exact duplication of any number, was not only very expensive but quite impracticable; but now with the improved tools and methods of the modern shop, skilled workmen can produce exceedingly accurate work, but not without care and perseverance. Three of these gages were required, one for manufacturing purposes, one for the inspector, and one as a master-gage. By the simplified method to be described, each of these gages can be finished ready for hardening with one setting on the master-plate, thus insuring great accuracy.

The old way of working to lines which have been laid out on the work, is fast being abolished, as accurate results cannot be obtained by this method. To work to the highest degree of excellence, each operation must be positively gaged so that it is certain when the work is finished that every step has been correctly performed. This article, which is a detailed description of the duplicate method of making the gages referred to, is intended not only for the inexperienced workman, but for the journeyman as well; therefore the writer has endeavored to start from the beginning and progress step by step so that each point will be absolutely clear.

Making the Master-plate

In order that the three gages be exact duplicates, it is first necessary to make a master-plate. The finished master-plate is shown at *C* in Fig. 1. This plate is made from tool steel, but is not hardened when finished. It can be rough turned in an engine lathe to within 0.020 inch and afterwards finished to the required size in a bench lathe. When the master-plate is ready for the bench lathe, the faceplate of the latter should be tested for accuracy by the use of a test indicator. After the master-plate is strapped to the lathe faceplate, one side should be faced off with a side tool *D*; the work is then reversed and the opposite face and outer half are machined. Both sides will then be perfectly parallel. The master-plate is now ready for the buttons which are used for locating it when boring the five holes shown. On a center line at right angles to the line *a*—*a*, the holes for the screws which are to hold the buttons in place are laid off to the required dimensions and drilled for a 1/8-inch tap. The depth of these holes should be about 1/4 inch. When the five holes are tapped so that the button retaining screws may be inserted in them, the center button is screwed in place and located in the center of the plate by using a depth gage. As all the buttons are hardened, ground and lapped on the outside to the same size, they may be set the correct distance apart by using as a gage a flat piece of steel having a thickness equal to the center-to-center distance minus the diameter of one button. The five buttons may be aligned by laying a straightedge across them.

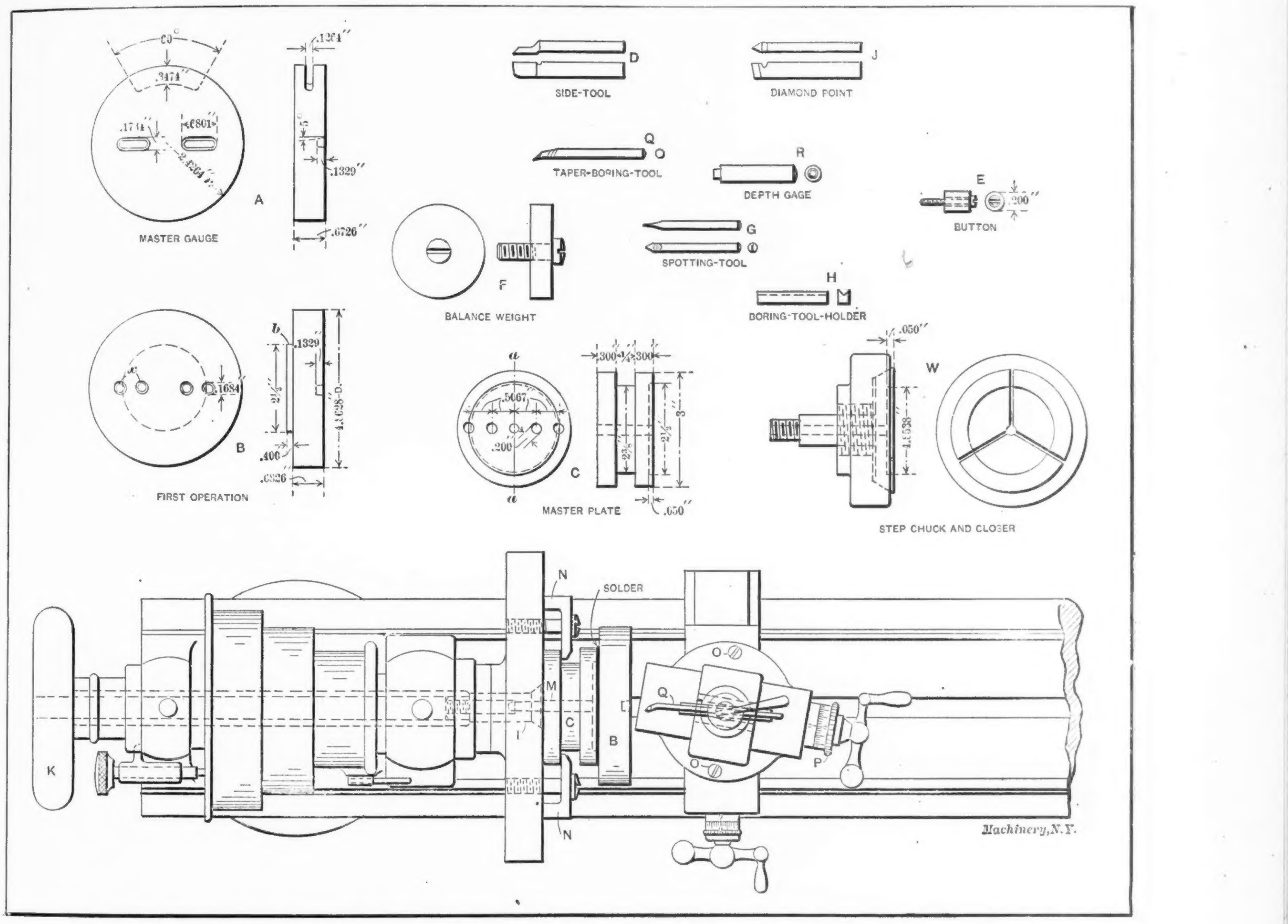

Fig. 1. Plan View of the Bench Lathe arranged for Boring the Tapered Holes in the Face of the Gage, and Miscellaneous Tools

The master-plate is now ready to be bored and reamed. After it is strapped to the faceplate, each of the holes is bored in its correct position by setting first one and then the other of the buttons true and then removing the button and boring the hole. The four outer holes should be bored first, the one in the center being machined last. Great care should be taken before boring a hole to set the button perfectly true. This is very important as the accuracy of the gages depends altogether on the accuracy of the master-plate. After a button has been set approximately true by the test indicator, balance weights *F*, which are made in different sizes, should be fastened to the faceplate to counterbalance the work which is, of course, offset with relation to the faceplate when boring the outer holes. This is essential because if the faceplate is not perfectly balanced, it will impair the accuracy of the hole

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being bored. When testing the balance, the driving belt should be removed from the cone pulley. After a button is indicated, it is removed and a center is made by the use of a spotting tool *G*. A No. 15 drill, in this case, is fed through the master-plate after which the hole is bored out to 0.198 inch with a boring tool, which is followed by a 0.200-inch reamer, thus finishing the hole to the size indicated at *C*. In the same manner the other four holes are spotted, bored and reamed to the same size. After the central hole is finished, a recess 2.5 inches in diameter and 0.050 inch deep should be bored at the same setting of the work. A light cut should also be taken on the outer diameter with a diamond-point tool *J*.

Annealing the Gages

After the gages are roughed out in an engine lathe to within 0.020 inch, they should be annealed by being packed in charcoal in a cast iron box with a close-fitting cover luted with fire clay in order to exclude the air so that the gages will not change too much when they are hardened. The iron box should be placed in the furnace and given a very slow heat for about three hours, after which the heat is shut off and the box is left in the furnace over night. On removing the gages, they will be found very soft and easy to work.

First Operation in the Bench Lathe

The gages are now ready for the first operation in the bench lathe. First strap one of them to the faceplate with the boss *b* out, and face this end. Then machine the boss *b* to an accurate turning fit in the recess previously bored in the master-plate. The gage should then be removed and clamped to the master-plate with two C-clamps, so that the two may be soldered together. Before soldering all oil should be removed from the surfaces, which may be done by spraying a little benzine over them and afterward wiping it off with a piece of clean waste. When soldering the gage should be heated over a Bunsen burner until the solder will run freely. Plenty of solder should be used at the point indicated in the engraving. When the parts are cooled they will be securely attached to each other and the C-clamps can be removed.

The plug collet *I* is next placed in the lathe spindle and the handle *K* is tightened. A tool steel plug, *M*, tapered at one end, is then driven lightly into the collet. This plug is turned to 0.2003 inch in diameter or 0.0003 inch larger than the master-plate holes. Care should be taken to see that the shoulder on pin *M* is below the surface of the faceplate. The pin *M* is next polished with fine emery cloth until it is a turning fit in the holes in the master-plate. The latter is then fastened to the faceplate with four straps *N*, as shown in the engraving, the pin *M* being inserted in the central hole. If the spindle does not balance perfectly, a small weight should be attached to it. The gage is now faced to a thickness of 0.6826 inch and turned to a diameter of 4.8628 inch. The work is now removed and the faceplate cleaned thoroughly, after which the master-plate is again attached to the faceplate with the center plug *M* in any one of the four outer holes. The spotting tool is then used to cut a center for starting a No. 25 drill, which is sunk to a depth of 0.122 inch. The compound rest is then swung to an angle of 5 degrees, as shown, by the loosening of the screws *O*. When the point of the boring tool *Q* is in contact with the surface of the gage, the graduated sleeve *P* is set to zero and a taper hole is bored to a depth of 0.132 inch and to a diameter on the outside of 0.1684 inch. These dimensions can be obtained very accurately by using a tapered plug-gage *R* which is made with a clearance of about 0.005 inch for grinding. In the same manner, the three remaining holes which are to form the ends of the slots shown in the face of the gage at *A*, are bored. Care should be taken to balance the spindle each time the master-plate is shifted from one hole to another.

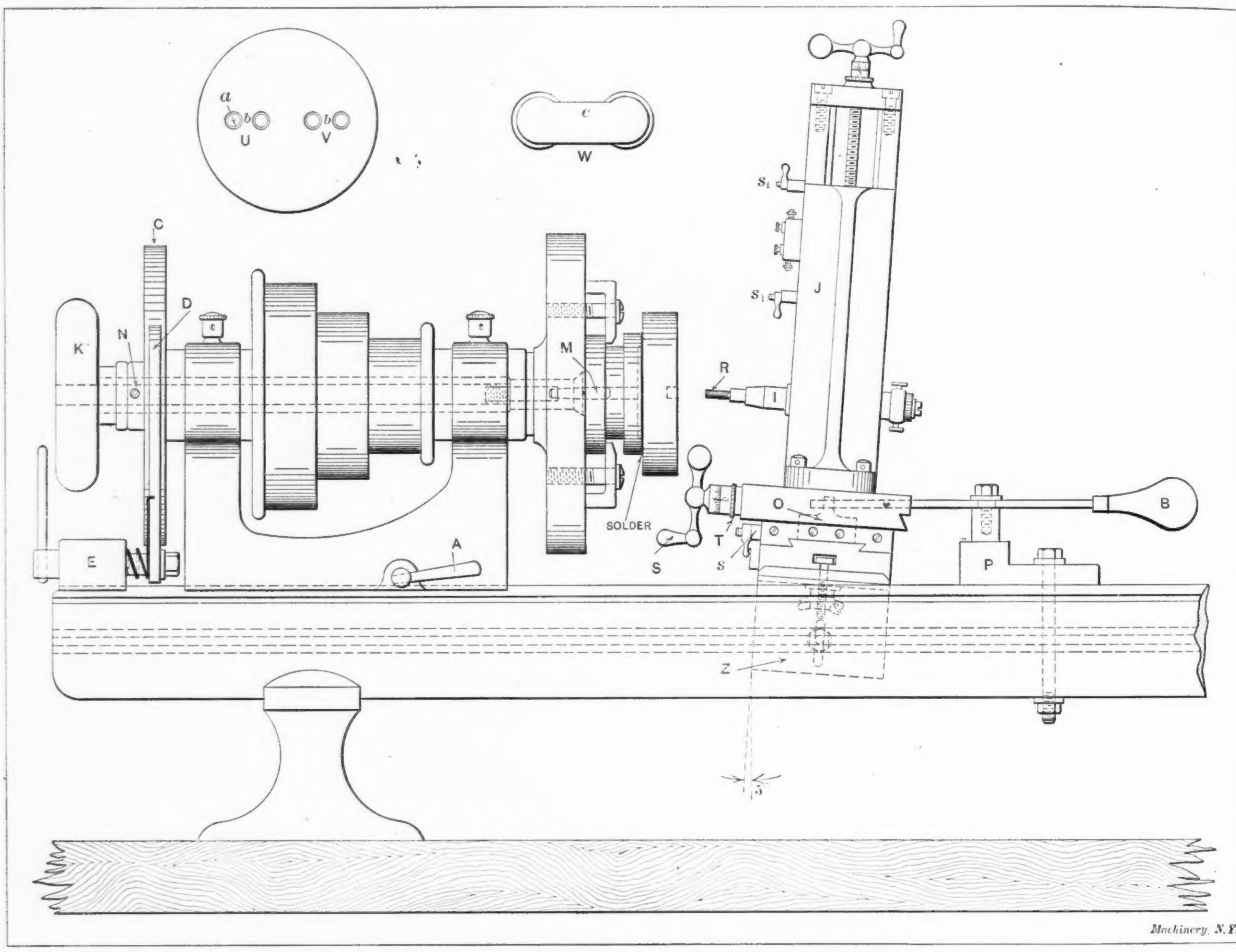

Fig. 2. Bench Lathe equipped with Indexing and Milling Attachments

Milling the Grooves

After the four tapered holes *U* and *V* (see Fig. 2) have been bored, as just described, the bridges *b* are milled away to form slots or grooves with tapering sides. The indexing attachment is first placed on the lathe headstock. The indexing plate *C* has 360 divisions. This is inserted by first removing the handle *K*. In order to make room for the block *E* with its indexing pawl *D*, the headstock is moved along the bed by

loosening handle A. Tapered plugs having outer ends which are parallel and of the same size should be placed in the two extreme holes in the gage. The master-plate (with gage still soldered to it) is then clamped to the faceplate with the plug M in the central hole. The pawl D should be inserted in the zero groove of the index-plate. An angle-iron Z is next fastened in the T-groove on the back of the lathe bed. On top of this angle-iron the milling attachment J is placed and adjusted so that the spindle will reach the two outer holes in the gage when it is moved to and fro by lever B, which is attached to stud O and fulcrumed on the stud of extension block P, which is fastened to the bed. To permit this movement of the slide by lever B, the cross-feed screw is removed. The plugs previously inserted in the end holes are now used to set the latter in a horizontal position or parallel with the movement of the cross-slide. This is done by inserting a test indicator in the spindle I of the attachment and moving the indicator across the plugs by lever B. When the indicator shows that each plug is exactly the same height, the screw N of the index-plate C should be tightened. The milling attachment should also be adjusted until the indicator shows that it is parallel with the face of the gage.

The end mill R, 0.150 inch in diameter, is now inserted in the spindle and the movable stops s on each side of a stationary stop on the horizontal slide, are set so that the mill has a horizontal movement, approximately equal to the center-to-center distance between the holes U. The mill is also set central vertically with these holes. The bridge b is then cut away by feeding the mill to and fro with lever B and inward by handle S. When the end of the mill is brought in contact with bridge b, before taking the first cut, the graduated sleeve T should be set to zero so that it may be used to determine the depth of the slot. After the bridge b has been cut away, the mill is fed downward until it just comes in contact with the bottom corner a of one of the holes. The movable stops s_1 on the vertical slide are now used to lock the mill against vertical movement. The mill is then fed across as before, machining the bottom of one slot as shown in the enlarged detail at W. The work is indexed 180 degrees and the milling operation described in the foregoing is repeated on the other pair of holes. Each slot would then appear as at W. In order that the sides c be cut away, the end mill is shifted so that it operates on the opposite side of the lathe center. The stops s on the horizontal slide are readjusted for this new position, the vertical stops remaining the same as before. After one side c has been milled, the work is again indexed 180 degrees and the milling operation is repeated.

The slots will now have tapering ends but straight sides. To mill the sides to a taper corresponding with that of the ends, the milling fixture is inclined to an angle of 5 degrees, as shown in Fig. 2. The end mill should then be replaced with an indicator, which is again used to test the parallelism of the face of the gage with the milling attachment. The sides of the slots can now be milled tapering in precisely the same manner as described for the end milling operation; that is, by milling one side, then indexing the work 180 degrees, and finally finishing the two remaining sides with the mill on the opposite side of the center. Very light cuts must be taken during this operation, and care should be exercised to leave a sharp corner on the side of each slot.

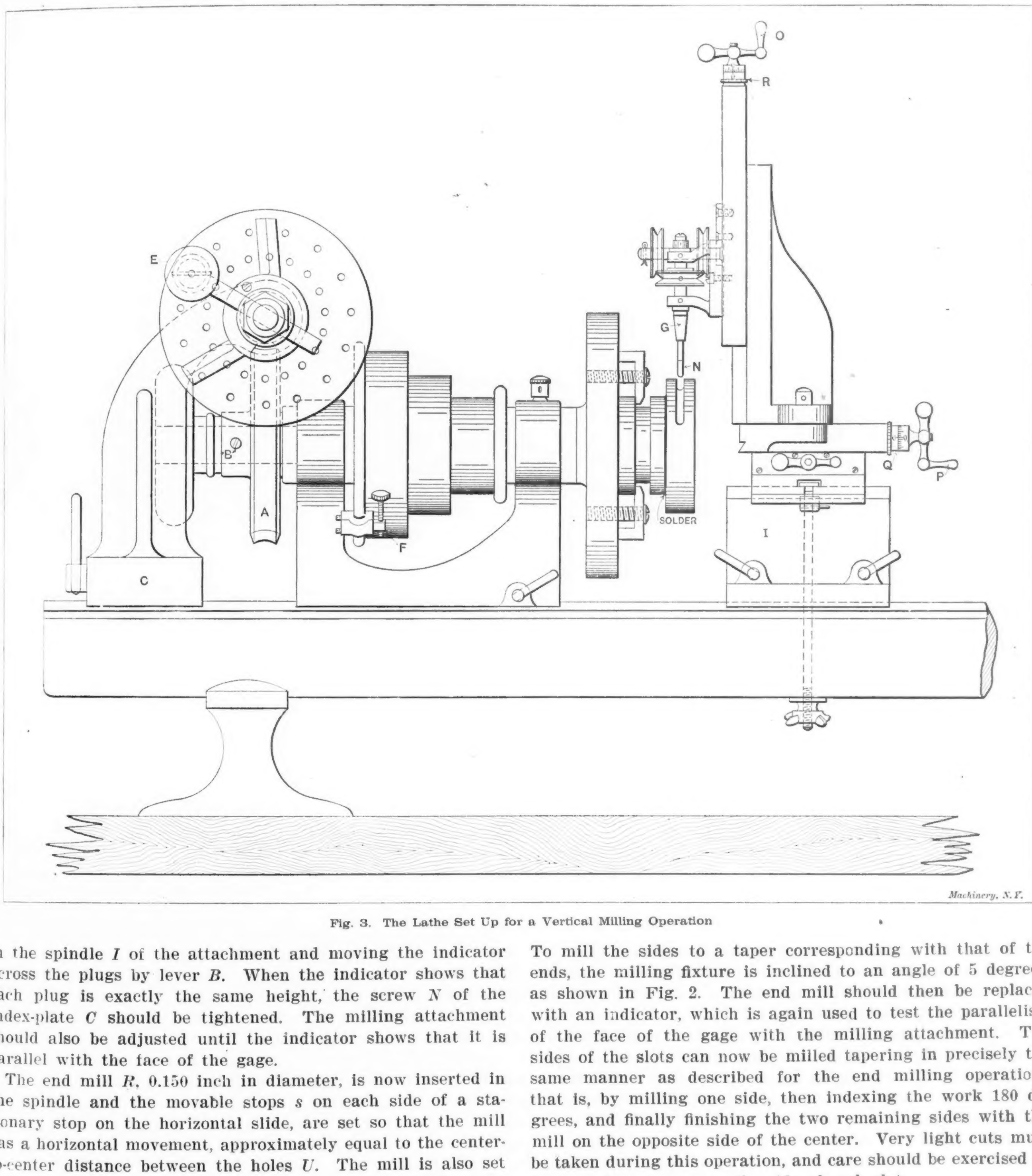

Fig. 3. The Lathe Set Up for a Vertical Milling Operation

To Mill the Circular Groove

Before milling the circular groove in the periphery of the gage, a dividing head should be attached to the lathe as shown in Fig. 3. The index-plate C, Fig. 2, is replaced with

a worm-wheel *A*. The worm meshing with this wheel should be set central by adjusting the bracket *C* along the lathe bed. An extension block *I* is also inserted beneath the milling attachment to raise it to the required height. The milling fixture is now used as a vertical miller by changing the position of the spindle as shown. An indicator is next placed in the spindle *G*, and with indexing handle *E* in the zero hole of the index-plate, the two slots which were previously milled in the face of the gage, are set parallel with the movement of the cross-slide by turning the lathe spindle; the screw *B* in the worm-wheel is then tightened. A male circular end mill 0.1164 inch in diameter is next inserted in the spindle. This mill must be set central with the sides and periphery of the gage. This can be done in the following manner: First lower the mill, which should be revolving; then turn handle *P* until a "listener" indicates that the cutter is barely in contact with the side of the work. Graduated sleeve *Q* should then be set to zero, after which the mill is raised and moved inward a distance equal to one-half the width of the gage plus one-half the diameter of the end mill. The latter is now central with the sides of the gage. By the same method, it may also be set central with the periphery. The work is now indexed 30 degrees, which will require with this particular dividing head, 15 turns of the indexing crank. A stop *F*, one of which is attached to the flange of the cone pulley on each side of the headstock, is then set against its striking point on the headstock. The work is then indexed 60 degrees or 30 turns in the opposite direction, after which the stop *F* on the opposite side is adjusted as before. These stops, in each case, should be so set that the indexing pin will just enter the zero hole of the dividing plate. Everything is now ready for milling the circular groove which, as shown in Fig. 1, has a length of 60 degrees. Prior to the milling operation, however, a hole 0.335 inch deep as indicated by the sleeve graduations, should be drilled at each end of the slot with a No. 35 drill. These holes will provide a clearance space for the end mill. A square end mill of 0.110 inch in diameter is then used to rough out the groove to a depth of about 0.295 inch. The male circular end mill is then employed for finishing the groove to the required depth. The work is fed by turning the indexing crank, and the stops *F* act as a positive gage, thus insuring that the slot will be the required length. The milling operation is now completed. After the attachments have been removed and the lathe arranged for turning, the gage should be removed from the master-plate by cutting away the solder with a side tool. One gage is now complete and ready for hardening. By the use of this same master-plate, obviously, the other two gages may be made precisely in the same manner as described in the foregoing.

Hardening the Gages

To avoid cracking or distorting the gages during the hardening operation, they are pack-hardened with ground charcoal in separate iron boxes. Each gage is laid in a basket made of 1/16-inch soft wire and wired together with a loop on one end, which is to serve as a grip for the tongs. The cover of the box is luted with fire clay to exclude the air while taking the heat. A hole should be drilled in one side of the cover for a 3/16-inch soft rod. This rod, which is to be used for gaging the heat, should extend to the opposite side of the iron box. After the latter has been exposed to a slow and comparatively low heat for about three hours, the rod is removed and if it shows that the gage has been heated sufficiently, the latter is removed and plunged into a sperm oil bath until it is perfectly cold. It is then heated a little to relieve any external strains which may have been set up, after which it should be laid on a piece of wood and allowed to cool slowly. It should not be left on a cold iron surface as the rapid change of temperature will cause excessive strains which will either crack the gage or warp it out of shape. After the gage is cooled sufficiently to permit handling, it should be polished so that the temper can be drawn. This may be done by the use of a Bunsen burner. To prevent the gage from coming into direct contact with the flame, it should be placed on a 5/16-inch steel plate and heated by contact with the plate. When drawing the temper, the gage should be turned over frequently so that it may be drawn evenly all over to a light straw color. It should then be allowed to cool naturally, wrapped in a piece of waste.

Grinding the Gages

The grinding operations are performed in practically the same way as the milling or turning, the only difference being that a wheel is used instead of a tool or cutter. The gage is, of course, mounted on the master-plate as before. Great care must be exercised before soldering the gage to the plate, that it be located in the proper position relative to the holes in the master-plate. This may be done as follows: First clamp the master-plate and gage together, with two C-clamps, then place a close-fitting plug in each of the two extreme holes in the master-plate. These plugs, which should extend about one inch beyond the surface of the plate, are next placed on the top surface of a parallel block which should be high enough to clear the diameter of the gage. This block should be mounted on an accurate surface plate so that a test indicator may be used to set both grooves in the face of the gage parallel with the plugs in the master-plate. After the grooves have been tested on one side, the master-plate should be turned over, so that the opposite sides of the plugs rest on the parallel block. If the indicator then shows the same reading as before, the gage may be soldered to the plate. The latter is then mounted on the faceplate of the lathe with the plug *M* (Fig. 1) in the central hole, and the gage is indicated on its face and periphery. If it runs out more than 0.004 inch it should be reset. If, however, the error is small enough to permit truing, rough grind the face and periphery leaving about 0.001 or 0.002 inch for finishing after the grooves are ground. This precaution must be taken to insure accuracy as hardened steel changes during a grinding operation after the outer scale is removed. In grinding the ends of the grooves, a diamond lap 0.075 inch in diameter is used. The end of this lap is charged as well as the body. When the ends are being ground, the slide-rest is set to an angle of 5 degrees and the procedure is practically the same as when the ends of the slots were bored; 0.0002 inch should be left for hand lapping. The diamond lap should run at the fastest speed obtainable and the work should revolve at the slowest. To grind the sides of the grooves, the same diamond lap is used and the machine is set up as shown in Fig. 2. A circular end diamond lap 0.115 inch in diameter is used for grinding the circular groove, and the machine is equipped with the same attachments as are illustrated in Fig. 3.

After the periphery and one side of the gage have been finished, the side next to the master-plate still remains to be ground. A step chuck and closer *W* (Fig. 1) is placed in the headstock spindle and three small pieces of sheet steel of the same thickness as the slots in the chuck are placed in each slot. The chuck is then tightened by means of the handle *K*, after which a recess about 0.050 inch deep and large enough in diameter to be a snug fit for the gage, is bored. The chuck is then loosened and the sheet steel pieces removed. The ground face of the work is next inserted in this recess, which should be very carefully cleaned, and the chuck is tightened. Care should also be taken to have the inner face of the gage against the chuck. If the work when tested on the periphery runs true, it may then be finished, first by using a coarse carborundum wheel and afterwards a No. 120 emery wheel; 0.0002 inch should again be allowed for lapping.

When the three gages have been ground as described in the foregoing, the faces should be lapped by rubbing them on an accurate surface plate, using a very little fine emery with plenty of benzine. A smooth and bright finish may be obtained by using a dry and clean plate. In this way, each gage is brought to the exact measurements required. The grooves are draw-lapped with a flat copper stick, powdered emery and sperm oil being used. For a final finish on very accurate work, the copper lap should be followed by one made of boxwood, the abrasive being white powdered oilstone.

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A German company has been formed for making Wright aeroplanes. The capital is 500,000 marks ($119,000). The principal stockholders in the company are leading German firms, including the Krupp Co., the Borsig Locomotive Works, Ludwig Loewe & Co., and the General Electric Co. of Germany.

MAKING THE DeVILBISS PLIERS—1

By ETHAN VIALL*

A shop making one or more small specialties in quantities is always interesting because of the individual problems in tools and jig work that must of necessity be worked out if the output is to be produced at a profit. The cost of the tools and jigs increases, of course, with the complexity of the article or articles and consequent increased number of parts. Many comparatively simple looking manufactured articles are, in reality, very difficult to produce and a small fortune has been spent on them before a single one was put on the market. The cost of tools and the time taken to develop and make them, has proved the downfall of many manufacturers of really first-class articles that were ready sellers. A bunch of orders on hand with no means of filling, is worse than no orders, and if they are filled with articles made in any old way, it is still worse, if that be possible.

If the manager of a firm is wise, and has a fair amount of money back of him and confidence in the factory product, he will look to his tool and jig equipment and see that it is well along, before he begins to do any amount of advertising, so that he will be in a position to handle large orders with promptness before he really begins to push the selling end in earnest. However, the ideal conditions are not always obtainable and a manager often has to make the best of the conditions binding him. Few indeed are so fortunate as the general manager of the DeVilbiss Plier Co., Dundee, Mich., who has in the company with him, men of wide business and mechanical experience who thoroughly understand the principles of business success; these men know a good thing when they see it and have the money to back their opinions. It is, therefore, with unusual gratification that we are enabled through the courtesy of the manager, Allen DeVilbiss, Jr., and factory manager, W. F. Gradolph, to give in detail, each step in the manufacture of their pressed steel, cam-motion, parallel-jaw pliers, and to show every tool and jig used.

Fig. 1. Plant of the DeVilbiss Plier Co.

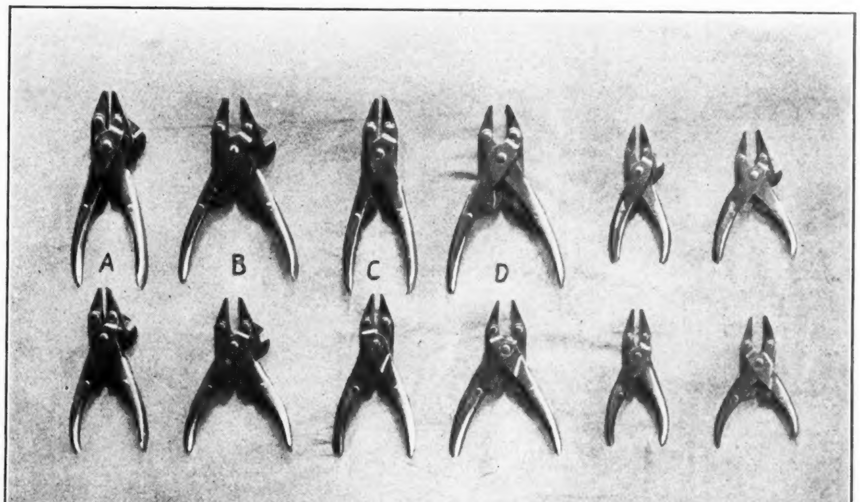

Fig. 2. Product of the DeVilbiss Plier Co.

The factory building, Fig. 1, is two stories high, light and roomy and of concrete construction, having a main floor of heavy concrete, which makes an ideal floor for punch press work. This is the largest factory devoted exclusively to the making of pressed steel pliers in the country. The toolroom, Fig. 3, while not imposing, is unusually well equipped and amply large for the work required. All special tools, jigs, punches and dies, are kept in a big concrete vault, although the building itself is practically fire-proof.

In order to give the reader a clear idea, from the beginning, of the kind of pliers manufactured, a number of sizes and styles are shown in Fig. 2. *A* is a parallel-jaw, cam-motion cutting plier; *B* is the same but with a spring inserted to keep the jaws open; *C* is another parallel-jaw, cam-motion plier; *D* is the same with a self-opening spring, while the others are simply different sizes of similar types.

Taking up now the various parts that are used in these pliers, a list of which follows, we will give the order in which the various operations are performed on each one and then show the tools and jigs used in rotation.

Parts of DeVilbiss Plier

1. Handles, drawing steel. 2. Jaws (cutting), drawing steel. 3. Jaws (plain), drawing steel. 4. Cams, cold rolled steel. 5. Cutter blades (moving), tool steel. 6. Cutter blades (fixed jaw), tool steel. 7. Links, cold rolled steel. 8. Screws, rivets and springs.

In the above list, handles are divided into outside, inside and spring handles, the last named having a tongue in them for the end of a coiled spring.

Operations on the Handles

The order of the shop operations through which the handles go, is as follows:

1. Blanking. 2. Serrating. 3. Bending and stamping name. 4. Rough shaping. 5. Straightening or finish shaping. 6. Drilling. 7. Hand reaming on three-spindle drill. 8. Burring inside on 1/8-inch emery wheel. 9. Countersinking to remove burrs. 10. Tumbling. 11. Reaming on three-spindle drill. 12. Assembling.

Both the inside and outside handles pass through the same operations, except that the latter are offset between the third and fourth operations. Fig. 4 will make plain the first six operations on the inside handles, and the first seven operations on the outside handles. *A* is the blank; *B* is the serrated blank; at *C* the blank has been bent and the name stamped on it; at *D* it has been rough shaped; at *E* it has been straightened, and at *F* it has been drilled. Going back now to *C*, we follow it down to step *G*, which shows a blank with an outside offset; *H*, the outside rough shaped; *I* the outside straightened; and *J* the outside drilled. *K* shows an outside handle tongued at *T* for a spring, which is done simultaneously with the straightening operation on those intended for spring pliers.

A, Fig. 5, shows the blanking punch used, and *B* the die and stripper plate, which are of the usual form. *C* is a

* Associate Editor of MACHINERY.

blank like *A* in Fig. 4. After blanking, the handles are placed in the sub-press base *D*, and serrated with the punch *E*, producing the result shown at *F*. The top and bottom of this serrating sub-press are made of steel, for as the work is done in a board drop-hammer, cast iron would not stand the jar and strain. The hammer used has been changed so that nearly double the blow for which it was intended can be delivered, as a very powerful blow must be struck to make satisfactory serrations in this way.

The serrated blanks are next bent and the name stamped on them in the formers *A* and *B*, Fig. 6, the name of the firm being stamped on both forks of the blank by plug stencils *C*, inserted in the die. These stencils may be easily removed when damaged or worn, and replaced by new ones. The object of the bending is, of course, to give the blank the proper curve for the subsequent shaping. *E* and *F* are the punch and die used to offset the outside handle, as at *G*. The rough shaping is done with the forming punch and die *A* and *B*. Fig. 7, both inside and outside handles being shaped in the same die, though in shaping the inside handles the blocks *C* are set in. The straightening dies, *D* and *E*, are made on the ordinary "squeeze die" principle and in this case all the squeezing is done just back of the fork of the handle by the sliding blocks *F*, which are shoved in by the bevels *G* on part *E*. The punch *H* presses the handle down onto the form, coming into contact with the handle where the fork begins, just as the sliding blocks press in the sides.

Drilling the holes in the handles is done in the jig Fig. 8, which has a removable center block, the handle being locked in by an eccentric. These holes are next hand reamed in a three-spindle drill press, as shown in Fig. 9, each spindle holding a reamer for its respective hole. The burrs are now ground off on the inside with a ⅛-inch emery wheel, which will not be illustrated as practically the same operation will be shown on the jaws later. The outside burrs are removed by countersinking as in Fig. 10, after which the parts are tumbled for an hour in a mixture of sawdust, sal soda and water; then, merely as a precautionary measure, they are again hand reamed exactly as previously shown in Fig. 9, when they are stored ready for assembling.

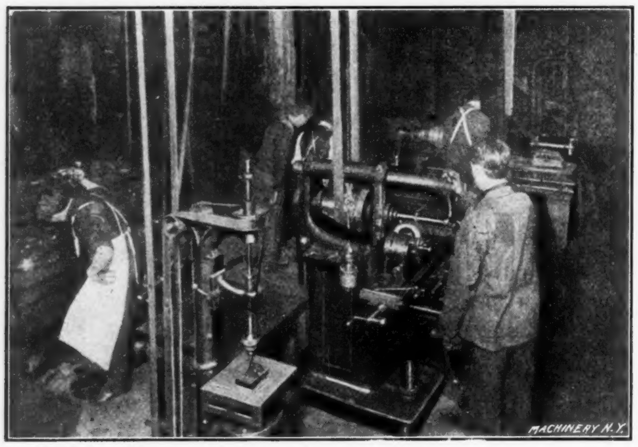

Fig. 3. General View of the Toolroom

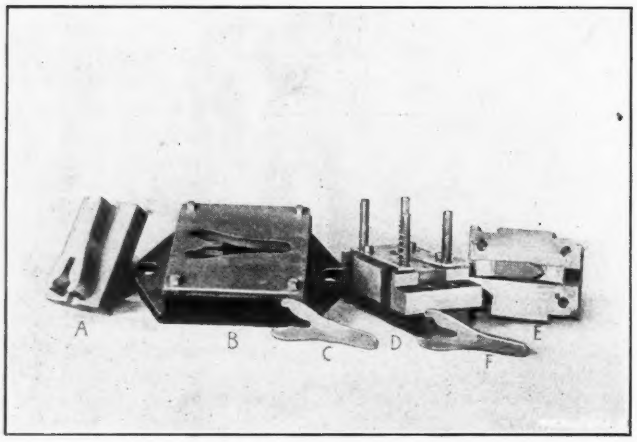

Fig. 5. Handle Blanking and Serrating Punch and Die

Jaw Operations

The shop operations on both the cutting and plain jaws are similar, but for convenience in describing the tools, the list will be arranged as follows:

Cutting Jaws	Plain Jaws
1. Blanking.	1. Blanking.
2. Slotting.	2. Slotting and piercing.
3. Forming.	3. Forming.
4. Annealing.	4. Annealing.
5. Flattening and serrating.	5. Flattening and serrating.
6. Removing burrs and squaring sides.	6. Removing burrs and squaring sides.
7. Drilling.	7. Drilling.
8. Removing outside burr on disk grinder.	8. Removing outside burr on disk grinder.
9. Countersinking cam holes.	9. Countersinking cam holes.
10. Cutting off ends in milling machine.	10. Cutting off ends in milling machine.
11. Reaming in three-spindle drill press.	11. Milling wire slot.
12. Carbonizing.	12. Reaming.
13. Removing inside burr on ⅛-inch emery wheel.	13. Carbonizing.
14. Rough polishing.	14. Removing inside burr on ⅛-inch emery wheel.
15. Drawing to a blue color.	15. Rough polishing.
16. Finish polishing.	16. Nicking outside of jaw fork for a stop.
17. Assembling.	17. Drawing to a blue color.
	18. Finish polishing.
	19. Assembling.

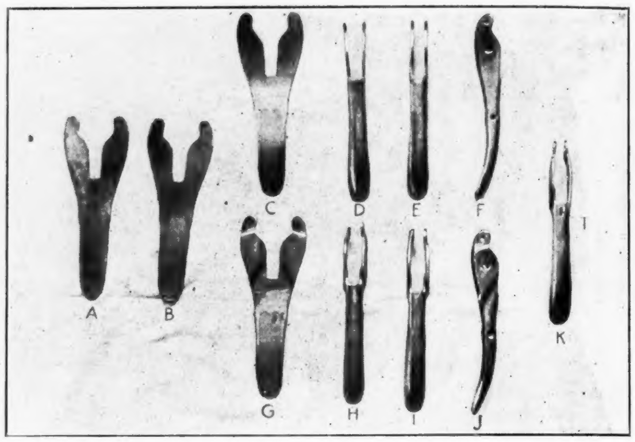

Fig. 4. Steps in the Evolution o, both Inside and Outside Plier Handles

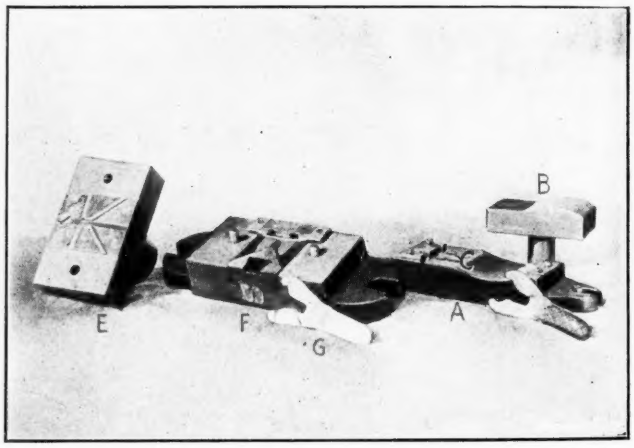

Fig. 6. Punch and Die for Bending, Name Stamping and Offsetting Handles

Most of the operations are graphically represented in Fig. 11, the upper row showing the steps in the evolution of the cutting jaws and the lower row those of the plain jaws; *A* is the blank, which at *B*, upper row, is slotted—lower row, slotted and pierced; at *C*, formed; at *D*, annealed; at *E*, flattened and serrated; at *F*, sides ground; at *G*, drilled; and at *H*, carbonized. While a few of the steps have been omitted in this illustration, they will be shown in detail when describing the tools and jigs for them.

A, Fig. 12, shows the blanking punch; *B*, the die; *C*, the slotting die, and *D*, the slotting punch used for cutting the jaws, while the same letters in Fig. 13 represent corresponding tools for the plain jaws.

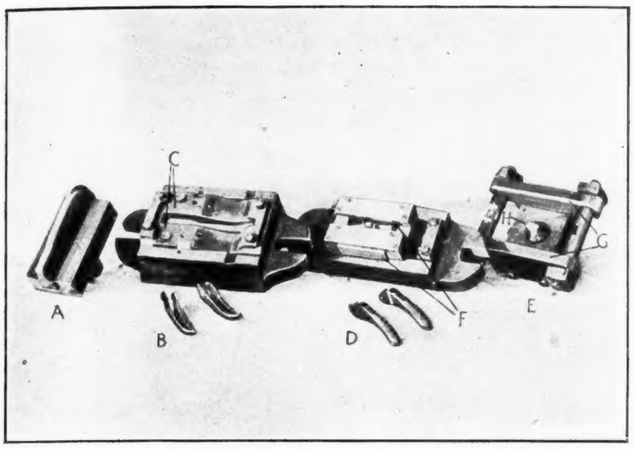

Fig. 7. Handle Shaping and Straightening Punches and Dies

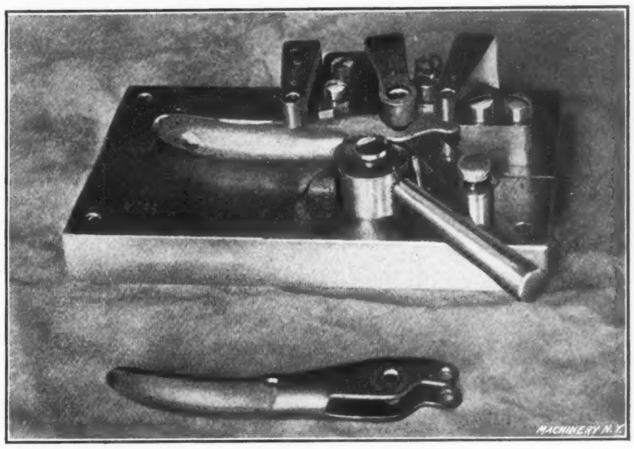

Fig. 8. Jig for Drilling the Handles

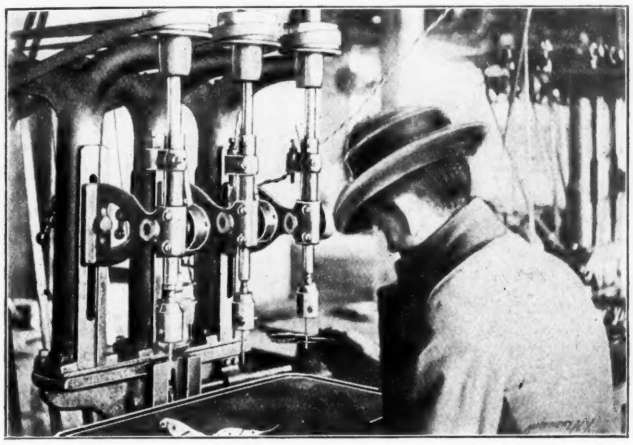

Fig. 9. Hand Reaming the Handles in a Three-spindle Drill Press

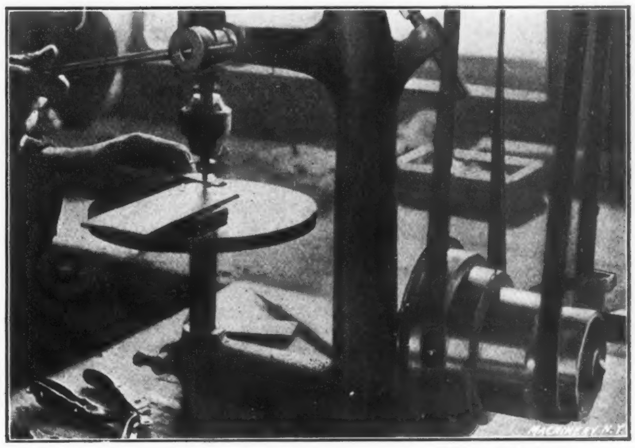

Fig. 10. Removing Outside Burrs with a Countersink

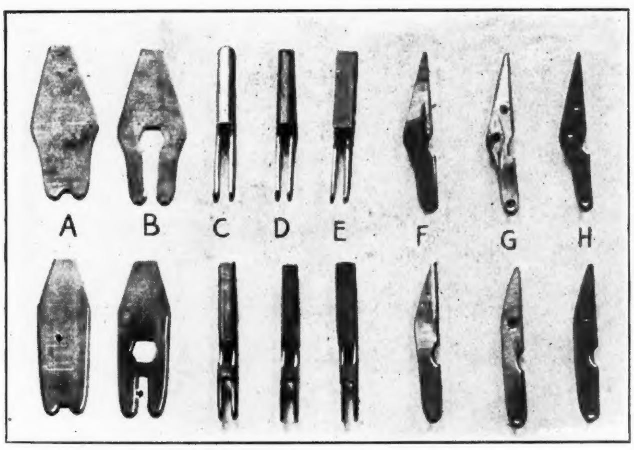

Fig. 11. Steps in the Evolution of the Cutting and Plain Jaws

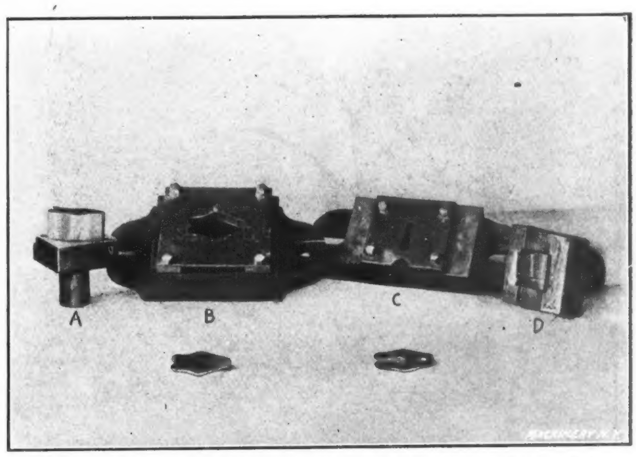

Fig. 12. Blanking and Slotting Punches and Dies for the Cutting Jaws

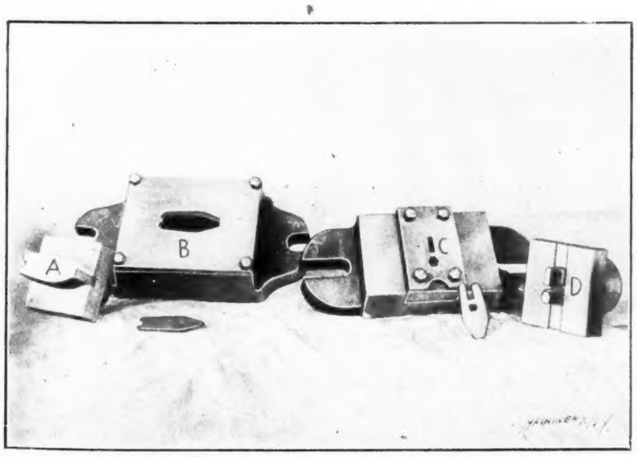

Fig. 13. Blanking, Slotting and Piercing Punches and Dies for the Plain Jaws

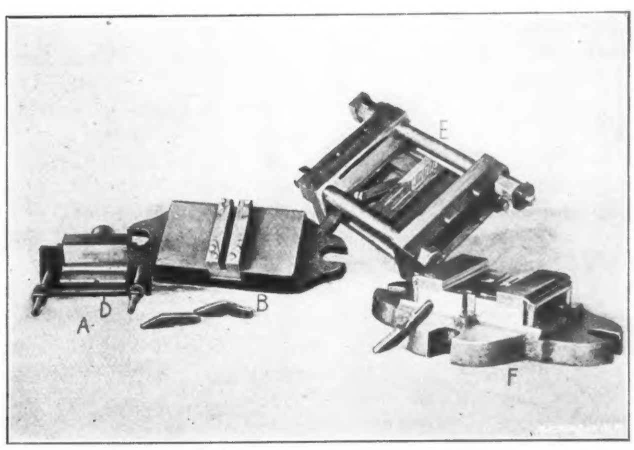

Fig. 14. Jaw Forming Punch and Die and Serrating Tools

The forming is done with the punch and die, *A* and *B*, Fig. 14, both styles of jaws being formed in the same die, as the locating blocks are so made as to only come in contact with parts of the jaws that are alike in both cases. The action of the "knockout" bar *D*, is interesting, as many an elaborate stripping scheme is less efficient. When the forming punch is set, this bar is at rest in the die slot slightly below the surface of the die, which allows the flat jaw blank to be located properly. As the punch descends, the bar strikes the bottom of the die slot and since it fits loosely on the punch studs, the punch can descend the full stroke without damage or making it necessary to have a very deep slot in the die. As the punch rises, the studs slip through the holes in the bar until the nuts are reached, when the bar rises, carrying the formed jaw with it. At *E* and *F* are shown the serrating tools, but as this is one of the most interesting and important operations, the tools are shown on a larger scale in Fig. 15. Between the forming and serrating operations, the jaws are annealed by heating to a dull red and allowing them to cool slowly, as indicated in the table of operations.

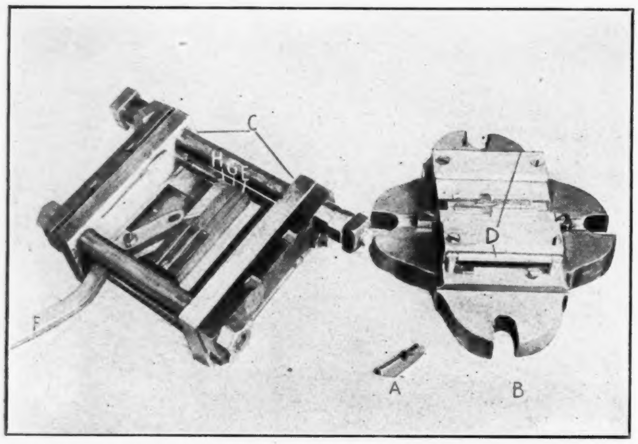

Fig. 15. Combination Punch and Die for Flattening and Serrating the Plier Jaws

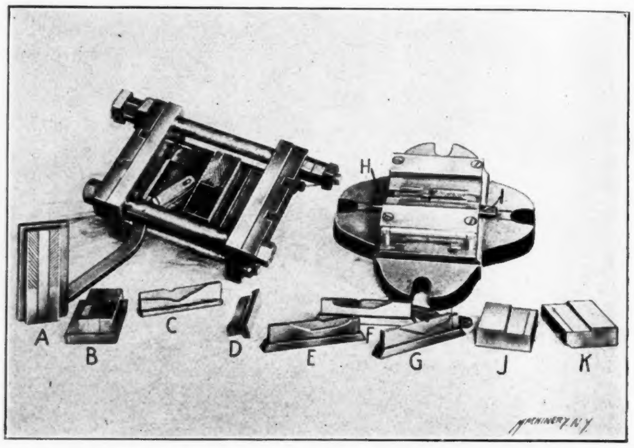

Fig. 16. Another View of Serrating Punch and Die with Attachments

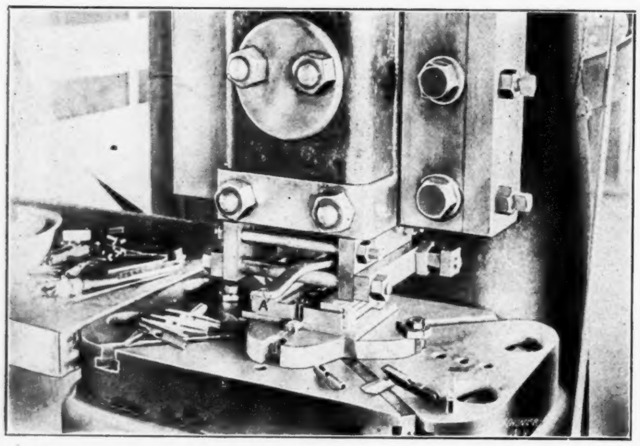
Fig. 17. The Flattening and Serrating Punch and Die Ready for Use

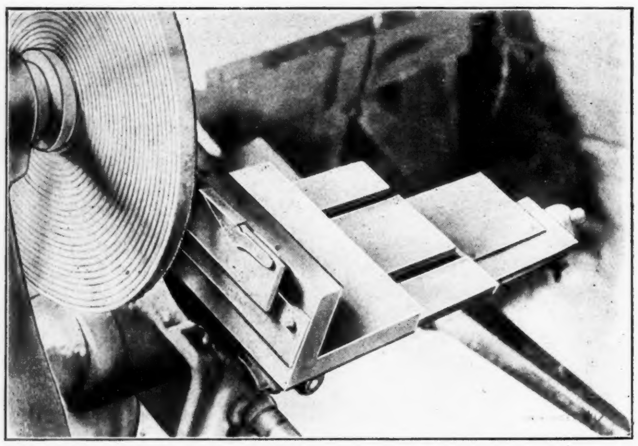
Fig. 18. Grinding off Overflow Burr left by Serrating Operation

Serrating the Jaws

The flattening and serrating of the jaw face, is done at one setting but with three strokes of the press, a formed jaw blank like *A* being held in the "squeeze" or clamping die *B*, the clamping slides of which are operated by the beveled parts *C* of the punch coming in contact with the rollers *D* which, in turn, press against the slides. In using this serrating punch, the face of the jaw is first flattened by the blank punch *E*; the lever *F* is then shifted over and the blank creased one way with the punch *G*; the lever is then pushed over as far as it will go, which on the stroke of the press, creases the jaw in the opposite direction, finishing the serrations.

The punch just referred to is the first one of this type made. It has the flattening punch at one side, but in the later ones the blank is put in between the serrating punches as at *A* and *B*, Fig. 16, which makes the handling of the shift lever much simpler, as the first stroke can be taken with the lever in a central position and then for the other two strokes it is shifted alternately to the left and right as far as the stop will let it go. At *C*, *D*, *E*, *F*, and *G* are shown forms for locating the different sizes of jaws in the die, which are made to fit a slot in the bed-plate and are held in by the two clamps, *H* and *I*. A pair of the sliding clamp blocks is shown at *J* and *K*, the releasing springs being shown projecting from the inner edges.

Fig. 17 shows the serrating punch and die set up in a punch press ready for use. Like the punch and die used in the drop hammer, this tool is made entirely of steel for the reason that cast iron is too weak. The credit for developing this tool is due to Mr. W. F. Gradolph, and the design is fully protected, but it thoroughly solves a problem that is far more difficult than it looks at first.

Finishing the Jaws on a Disk Grinder

The serrating operation just described, naturally leaves an overhanging burr on the sides of the jaw which is removed by grinding on a Besly disk grinder fitted as shown in Fig. 18. As there is considerable burr to be removed in order to properly square the sides of the jaw, a coarse grade of emery must be used on the disk to get quick results, but though coarse emery cuts fast it has a tendency to "shell off" in a case of this kind which, if not remedied in some way, necessitates frequent changes of the disk facing which is costly both in time and money; so in order to remove the burr quickly and at the same time avoid the shelling effect, a disk of number 16 emery is taken, coated with glue and number 40 emery put on which fills in and supports the coarser grains, at the same time allowing them to cut with practically the same freedom as at first.

Originally the jaws were so held in the die as to prevent the "overflow" but it was soon found that when flattened and serrated in that way they had a tendency to develop cracks along the edges which are entirely avoided by the present method.

Drilling, Milling and Reaming the Jaws

The drilling of both types of jaws for any one size is done in the same jig, two holes being drilled in the plain and three

in the cutting jaw. The style of drilling jig used for this work is shown in Fig. 19, and it will be noted that the locating of the jaw is done from the serrated face and the rounded ends, the movable or clamping slide coming in contact with the untrimmed end. After drilling, the burr left on the outside of the jaw around the holes is removed by holding it for an

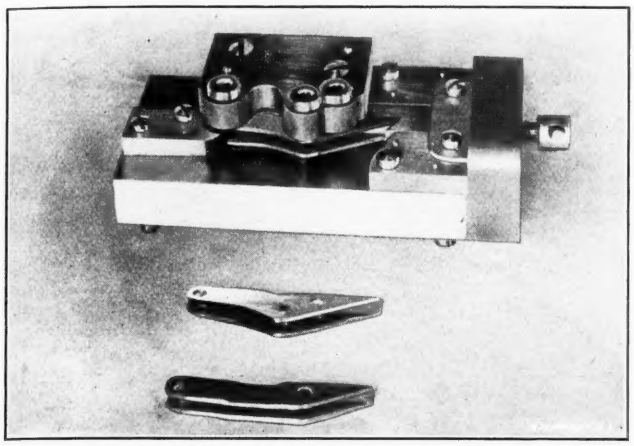

Fig. 19. Drilling Jig for the Jaws

instant against a disk grinder. Next the cam rivet holes are countersunk in a drill press, with a drill and the block *A*, Fig. 20. The outer ends of the jaws are now trimmed to exact length with a small side mill *B*, while they are held in the jig blocks *C* and *D* which are held in the milling machine

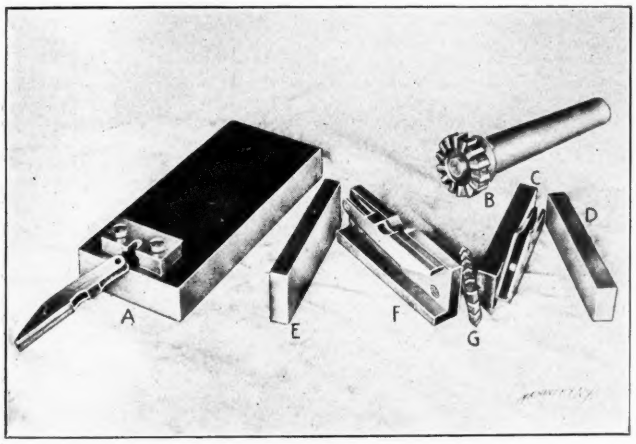

Fig. 20. Countersinking and Milling Jig and Tools

vise. The jaws are located in the block by two pins, one of which goes through the forward hole, the other supporting the cam end of the jaw. As in most of the other jigs, both styles of jaws are machined in the same jig.

Wire slots are milled only in the plain jaws, using the jig

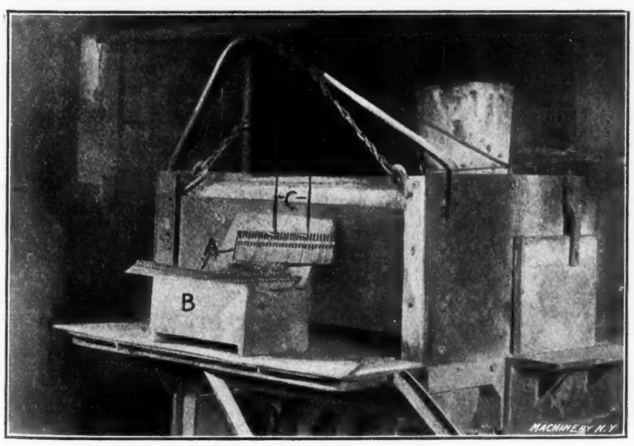

Fig. 21. View showing Method of Bunching Jaws for Carbonizing

blocks *E* and *F* in the vise, and the cutter *G*. The idea of milling a wire slot in only one jaw is that the serrations on the jaw opposite the slot will hold the wire better than two V-slots.

The holes in the jaws are reamed out on a three-spindle drill press, in the same way as were the handles; the jaws are then strung on two stiff wires as at *A*, Fig. 21, packed with bone in boxes like *B*, placed in he furnace shown and carbonized. After being heated the proper length of time, the boxes are drawn out one at a time, the lid removed and the clusters of jaws lifted out with wire hooks *C* and plunged into water. When dried, the inside burrs are removed with a 1/8-inch emery wheel, as in Fig. 22. The plan of leaving the removal of the inside burrs until after the jaws have been hardened, is a good one, as a wiry edge is not turned into the hole as would be the case if ground when soft.

The plain jaws are then "nicked" to a uniform depth on the back edges as at *A*, Fig. 23, where they come in contact with the handles, to make sure that the jaws will all open the same distance. This is done by setting the jaws on the fixtures and swinging them around the pin *B*, against the emery wheel.

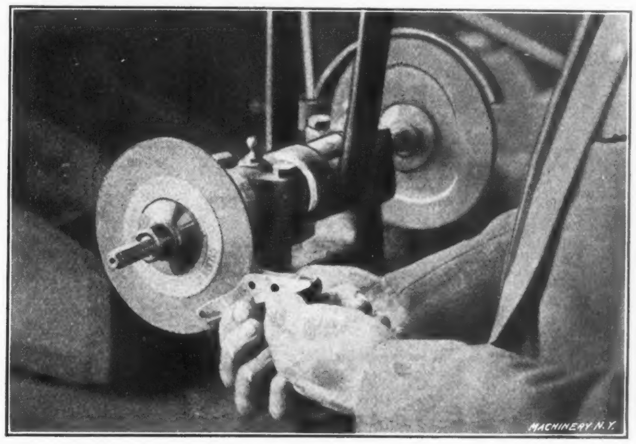

Fig. 22. Removing the Inside Burrs from Jaws after they are hardened

All jaws are now rough polished, drawn to a blue color in an oil bath, then finish polished and sent to the assemblers.

* * *

THE VALUE OF BOOK STUDY

An interesting illustration of the value of book study is related by a New Jersey business man who recently advertised

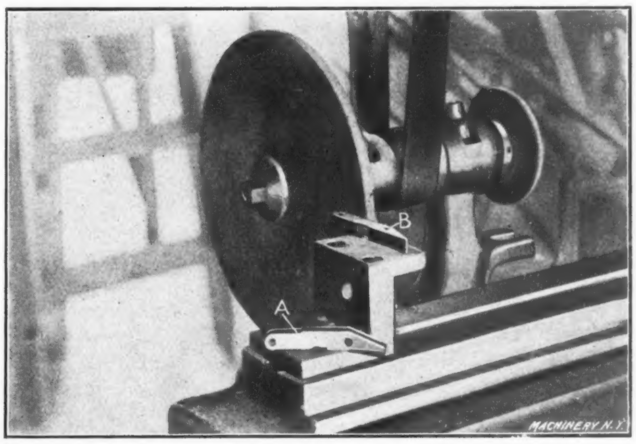

Fig. 23 Grinding a Stop on the Back of a Plain Jaw

for a chauffeur. One of the applicants was a well-educated man who had been conducting a "Queries and Answers" column in a motor journal. He was well-informed on the literature of automobiles, well-versed in thermodynamics, and familiar with the various text-books, trade catalogues, etc. Especially was he thoroughly conversant with all the intricacies and difficulties of the power plant of an automobile. He had, however, never run a machine, and wanted the experience. So he was engaged for a trial on the strength of his general knowledge, and a few days' practice was sufficient to make him a good driver; in fact he was often consulted as an expert in engine troubles. As one of our correspondents says, this goes to confirm the contention that book learning helps a man out, and a correspondence school's course is not entirely useless even in automobiling.

EXAMPLES OF BOX-TOOL DESIGN

By F. P. CROSBY*

A number of box-tools of different designs, with examples of the work for which each is intended, are shown in the accompanying engravings. While these tools are designed for some specific part, they can, of course, with slight modifications be adapted to other work; therefore a study of the different tools illustrated, will doubtless be of suggestive value to those engaged in the construction of box-tools for turret lathes and automatic screw machines. In all of the engravings the reference letters in the assembled and detailed views are the same for the corresponding parts.

A box-tool of the pilot type that is used to finish work after the surplus stock has been removed by roughing tools, is shown in Fig. 1. The work itself is indicated at *A* by the dotted lines, which represent a cone for a ball bearing. The pilot *B* enters the work before either of the cutters begins to operate on its respective surface. This pilot should be tempered and ground true. The inverted cutter *C* which sizes the flange of the cone, is held in position by a clamp *D*, which is forced down by a collar-head screw; and it is further

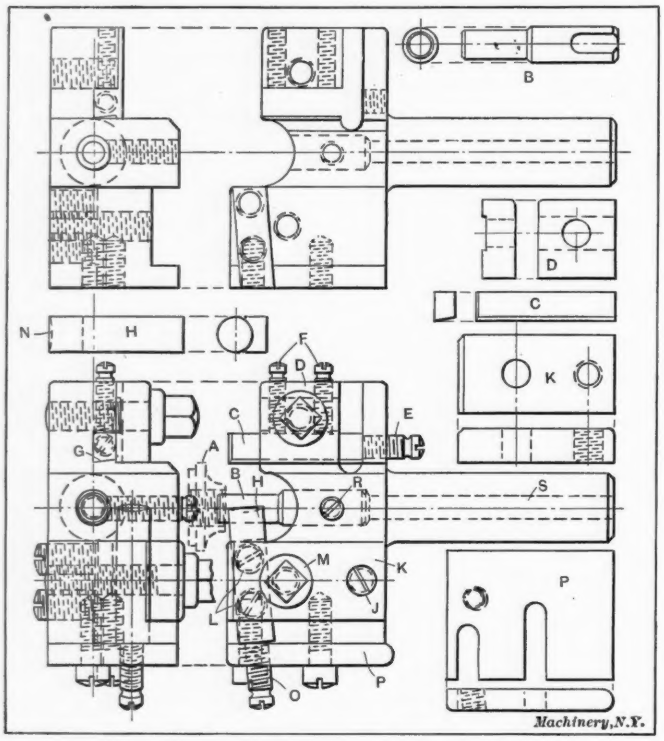

Fig. 1. Finishing Box-tool for Ball Bearing Cone

secured against a beveled shoulder at *G* by the set-screws *F*. The cutter is adjusted forward by the screw *E*. By loosening the screws *F* and the collar-head screw, the cutter may be easily removed for sharpening. The cutter *H*, which rests on a bolster as shown in the detailed view, is adjusted to cut to the proper diameter by the screws *L*, after which the clamp *K* is made level by the screw *J*. The collar-screw *M* is then used to secure the tool in place. The cutter is made from drill rod, and it is slightly cupped out on the cutting end as shown at *N*. The adjusting screw *O*, which passes through plate *P*, prevents the cutter from backing away from the work. This adjusting-screw plate has its screw holes slotted as shown in the detailed view, to obviate the necessity of removing the screws when it becomes necessary to sharpen the cutter. Pilot *B* is held firmly to the tool body by set-screw *R*. The hole *S* through the shank makes it easy to remove the pilot in case this is necessary.

A pilot box-tool for finishing another type of ball bearing cone, is shown in Fig. 2. The shape of the work itself is indicated by the dotted lines *A*. This tool is somewhat similar in its construction to the one just described. The cutters *B* and *C* are inverted, and are used to face the flange at *D*, and to turn it to the proper diameter. These cutters are held by the clamp *F* and screws *G*, and are adjusted forward by the screw *H*. The cutter *J*, which operates on the top of the stock, rests on a bolster of the proper angle (see detailed view), and is adjusted up or down by the screws *K*. The clamp *L* which binds against this tool, is beveled at *M* to correspond with the angle of the tool. This clamp is secured

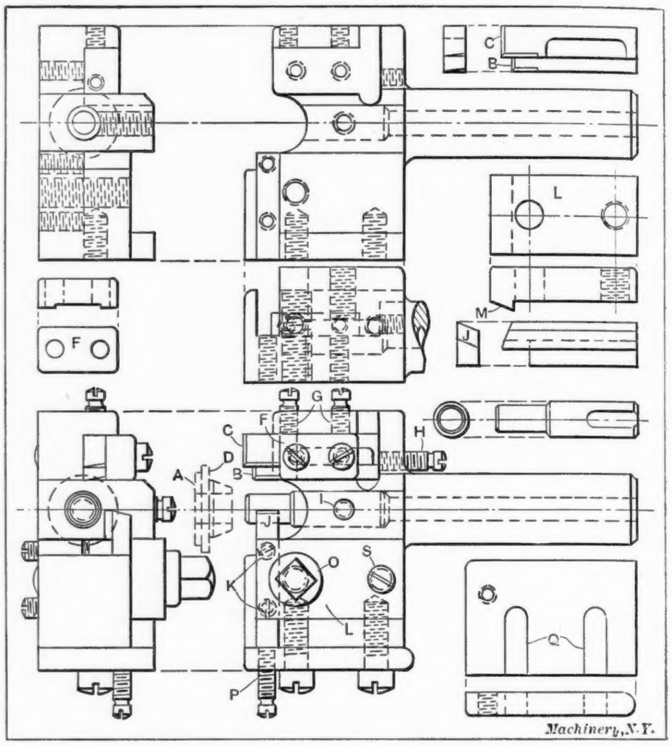

Fig. 2. Box-tool for Finishing Another Type of Ball Bearing Cone

by the collar screw shown, and it is leveled by set-screw *S*. The adjusting screw *P* prevents the cutter from slipping back. The holes *Q* in the adjusting-screw plate should be slotted as shown so that it will not be necessary to remove any screws when the cutter has to be taken out of the holder.

A box-tool for finishing a treadle rod cone for a sewing machine, is shown in Fig. 3. This tool is also of the pilot type. The cutters in it operate on opposite sides of the work which

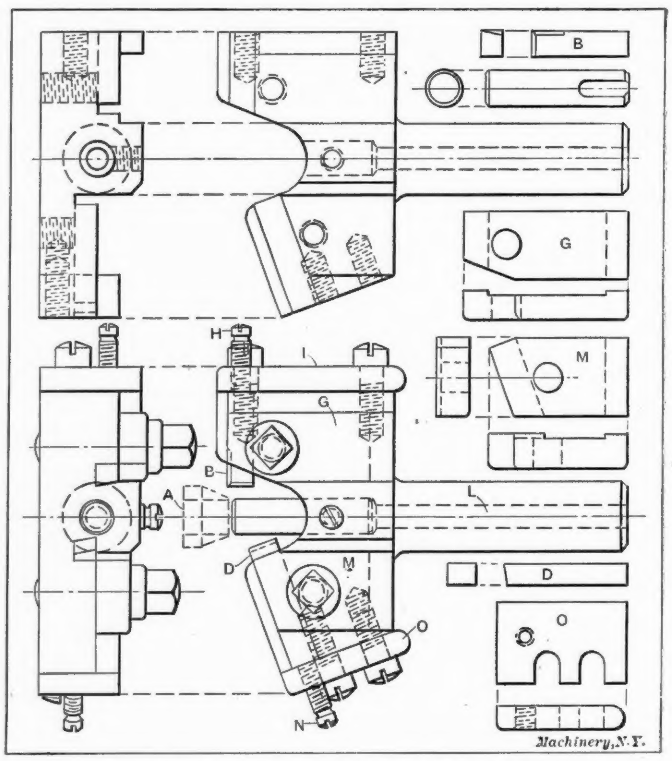

Fig. 3. Box-tool for Finishing Treadle-rod Cone

is again illustrated by the dotted lines at *A*. The inverted cutter *B* sizes the cylindrical part of the cone, while the front cutter *D* is set at the proper angle to finish the tapered part. The rear cutter *B* is held in place by the clamp *G* and a collar

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screw. It is adjusted forward by the screw *H* in the plate *I* which is held by screws as shown. The pilot is retained by a set-screw, and it is easily removed by inserting a small rod in the hole *L* which passes through the shank. The cutter *D* is held by clamp *M*, and is adjusted by screw *N*, which passes through a tapped hole in plate *O*, the plate being held to the body or base by screws. The screw holes in both the adjusting plates *I* and *O* are slotted to facilitate their removal. The general construction of the tool will be clearly understood by reference to the detailed views of the various parts.

The design of box-tool illustrated in Fig. 4 is used for finishing the bushing of a double-taper cone bearing, the form

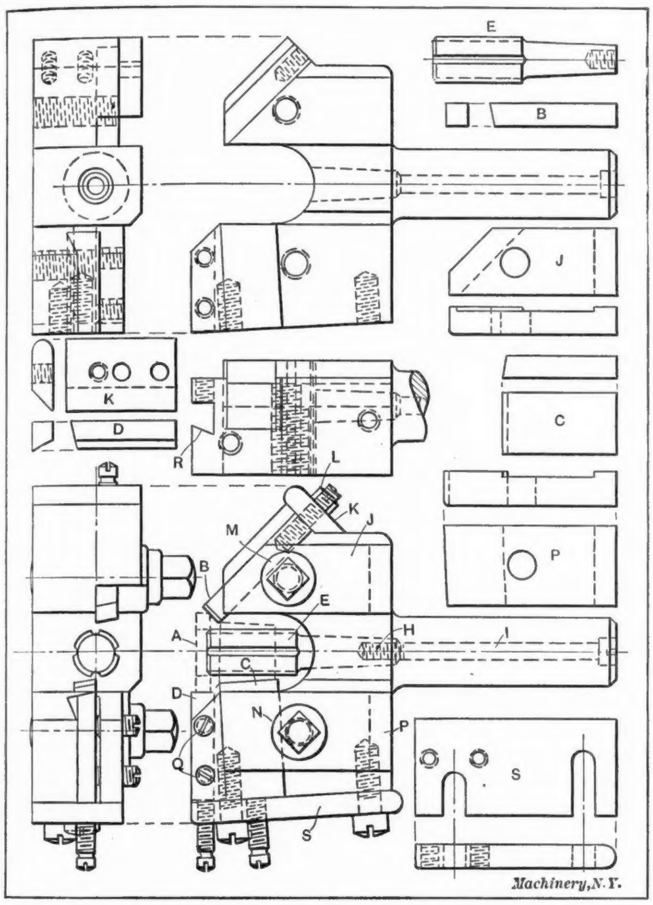


Fig. 4. Tool for Finishing the Bushing of a Double Taper Cone Bearing

of which is shown in dotted lines at *A*. The cutters are so arranged that they all cut on the center; that is, the cutting edges lie in a horizontal plane. The inverted cutter *B*, in the back, forms the short angular surface, and the cutter *C* in front forms the long tapering part of the bearing. The large diameter is turned to size by cutter *D*. The pilot *E* has a bearing in the bore nearly equal to the length of the work, and it is provided with oil grooves as shown. The taper shank of this pilot is tapped for the screw *I* which extends the whole length of the shank; this screw draws the pilot back to its seat. The adjusting-screw plate for cutter *B* is held in place by two screws. It is not necessary to remove this plate to take out the cutter, as the latter can be drawn out from the front after the collar-screw *M* is loosened. The cutter *C* is removed by slipping off the adjusting-screw plate *S* after loosening the collar-screw *N*. The cutter *D* is held in a dove-tailed slot (shown at *R* in the detailed view of the holder body) by two headless set-screws *Q*. It is also backed up by an adjusting screw in the plate *S*. These adjusting screws should all have fine threads, say from 32 to 40 per inch, and be nicely fitted so they will keep their adjustment and not give trouble.

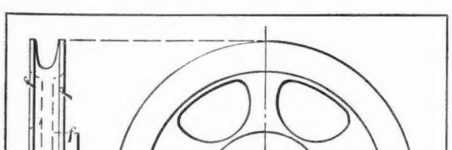


Fig. 5. Pulley that is finished by the Tools shown in Figs. 6 and 7

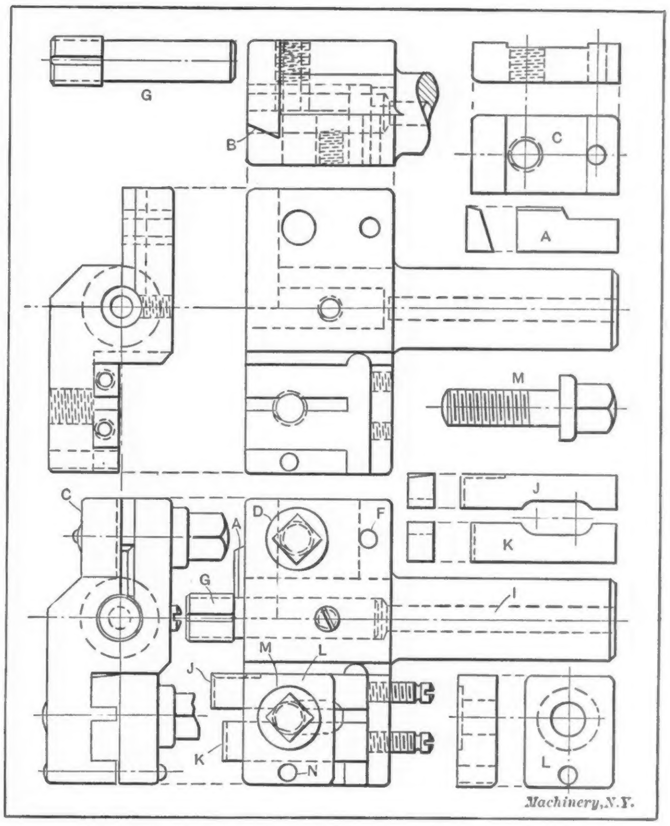


Fig. 6. Tool for Facing the Extension Hub Side of the Pulley

Fig. 5 illustrates a loose pulley for a sewing machine, that is finished as indicated by the marks *f*. This part is completed in two operations. The box-tool for finishing the side of the pulley on which the hub projects beyond the rim, is shown in Fig. 6. The inverted cutter *A* which faces the end of the hub, is fitted to a dove-tail *B*, which is shown in the detail view of the holder body. This cutter is held by a clamp *C* (clearly shown in the end view) from the under side, and it has no

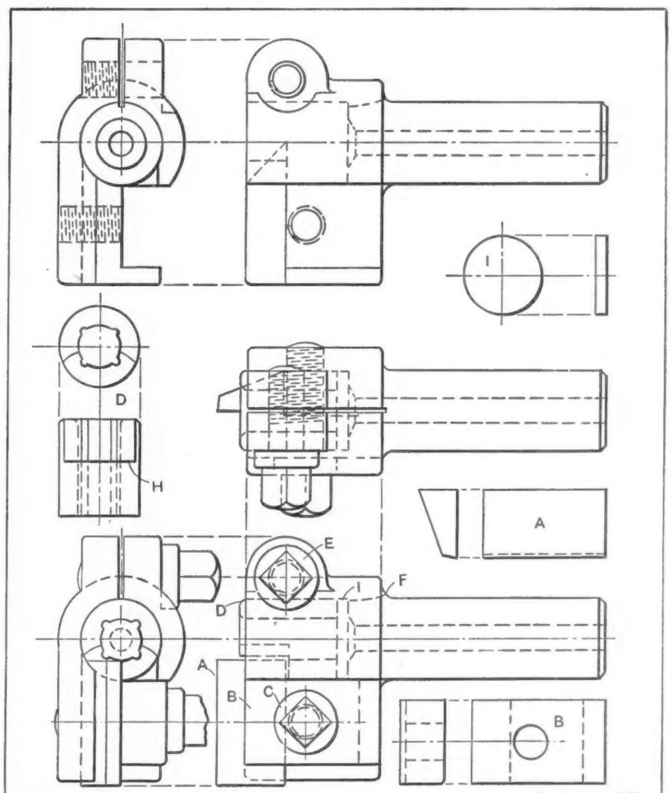


Fig. 7. Tool for Facing the Flush Side of Pulley

adjustment. The collar-screw *D* is tapped into this clamp, which is prevented from getting out of place by the dowel-pin *F*. The pilot *G* is made small in the shank, so that tool *A* may be so placed as to insure the removal of all burrs around the bore of the hub. The pilot is held by a set-screw and it is provided with oil grooves. The cutter *J* sizes the outside of the hub, and the cutter *K* faces the side of the pulley rim. These cutters are both held by the clamp *L* and the collar-screw *M*. The dowel *N* prevents the clamp from turning when the screw is being tightened. No side plates are used on this tool, and the cutters are all easily removed.

Fig. 7 shows the box-tool used for the second operation on the pulley illustrated in Fig. 5. As the hub is flush with the rim on the side for which this tool is intended, it needs only one cutter to face both. This is done by the cutter *A* which

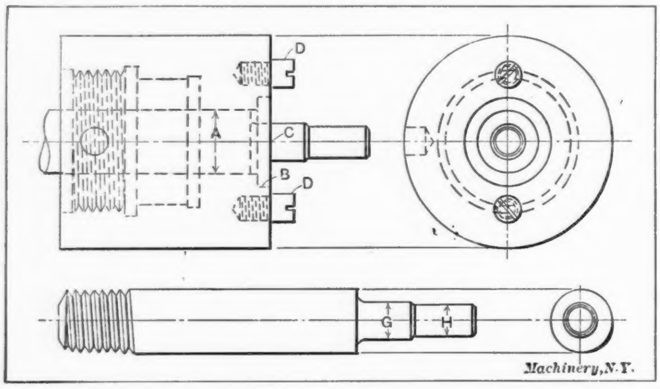


Fig. 8. Chuck and Arbor on which the Pulley, Fig. 5, is mounted during the Second Operation

is held in a dove-tailed slot in the front of the tool, and is fastened by the clamp *B* and collar-screw *C*. The bushing *D*, in which the end of the work arbor is supported, is held by the collar-screw *E*, and to obtain the necessary compression, the body of the tool is slotted as far back as *F*. This bushing is provided with oil grooves as shown in the detailed view, and one side is cut away as far back as *H* to clear the cutter *A*. The end of the arbor that the work is mounted on, is 1/16 inch smaller than the bore of the pulley, which allows the cutter to be set in far enough to prevent any burr forming at the edge of the bore. A disk *I* is inserted back of the bushing *D* so that the latter may be easily removed by passing a rod through the hollow shank.

Fig. 8 illustrates the arbor and chuck used for the second operation on the loose pulley, the box-tool for which has just been described. This chuck is fitted to the nose of the spindle, and the work is mounted on the projecting arbor and driven by the pins *D*. The bore *A* through which the work arbor passes, as well as the face *C*, should be ground after hardening, to insure accuracy. The arbor itself, which is shown in detail, should also be ground after hardening. The thread on the end of this arbor should be of a coarse pitch, enabling the arbor to be removed quickly from the draw-spindle, as it has to be removed for every piece operated on. The diameter *G* is made a driving fit for the work, and the end *H* is a running fit in the bushing of the box-tool. The counterbore at *B* is to provide clearance for the hub of the pulley which projects beyond the rim on one side.

* * *

The total tonnage of vessels launched during 1909 in all the countries of the world amounted to 2,006,500 tons. Of this tonnage, more than one-half, or 1,017,000 tons, was built in the United Kingdom and 258,000 tons in the United States. The total tonnage for the whole world shows a decrease of 40 per cent from that of 1906. Of sea-going merchant steamers of over 3,000 tons, about 75 per cent were built in the United Kingdom.

ECONOMY IN GRINDING*

By JOHN J. THACHER†

It is very often the case that a grinding machine falls short of its highest possible output by reason of the inattention of the operator to some of the short cuts and time-saving methods that have been highly developed in the use of other machine tools. It is the case with grinding machines as with other machine tools, that the development of short cuts and kinks of various sorts, greatly increases the aggregate output of the machines. The lack of such time-saving methods is the reason for the unfavorable attitude of some firms to the grinding process. It is almost always the experience of a demonstrator sent out by the manufacturer of grinding machines, that his results are not maintained by the operator. First one little kink is lost sight of, then another, and the time increases very slightly on each individual piece ground, but the aggregate of the day's output is soon considerably below what it should be.

A grinding machine will size work to a commercial degree of accuracy with remarkably little attention on the part of the operator, but the quantity output of a machine is very largely dependent on the ability and willingness of the operator to hustle; hence the reason for the almost universal prevalence of the "piece system" in the grinding department.

Several little kinks that I have observed at the works of the Brown & Sharpe Mfg. Co. may be of interest to those who would increase the output of their grinding machines.

Spotting Work for the Back-rests

Spotting work for the back-rests is a great help to the operator in several ways. When a piece of work is placed in the machine, assuming that the automatic cross-feed stop shield shown at *A*, Fig. 1, has been adjusted from a previous piece ground, the grinding wheel should be run back from the work about 1/32 of an inch. This is accomplished by turning the cross-feed handwheel *B* about one revolution in the opposite direction to that in which it is automatically revolved. The table carrying the work can now be moved by the handwheel marked *C*, provided for the purpose, bringing the various back-rests successively in front of the grinding wheel, as shown in Fig. 2. The wheel is then fed into the work by hand without reciprocating the table; it should be fed into the work until the diameter where the shoes of the steady rests bear is within one-thousandth inch of the

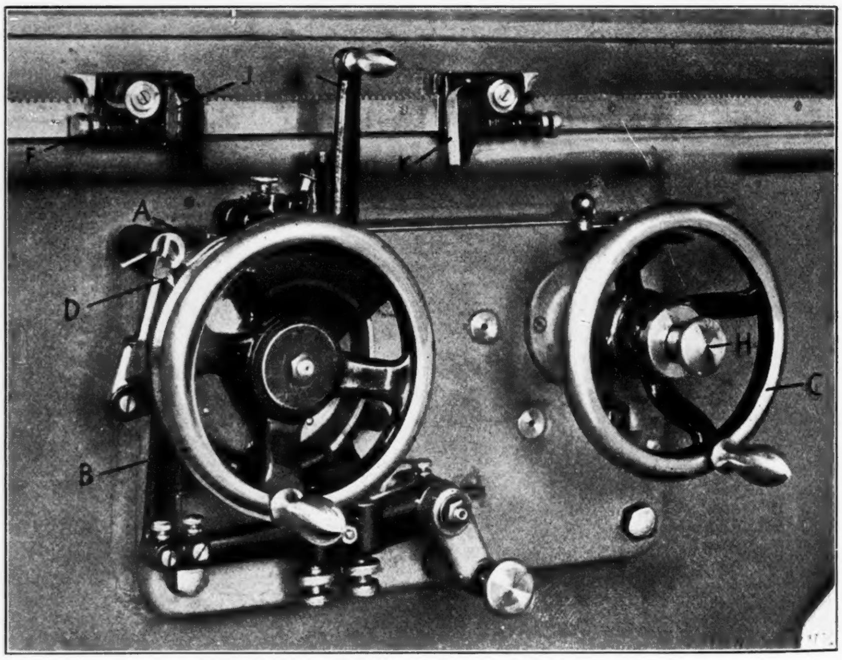


Fig. 1. Controlling Mechanism of the Brown & Sharpe Grinder

* For additional information on this subject, see the following articles previously published in MACHINERY: A Factor in Grinding, June, 1909; Cylindrical Grinding, May, 1909; Form Grinding Operations in the Shops of the Landis Tool Co., August, 1909; Grinding and Grinding Machines, April, 1908; Helps and Don'ts for Grinding, August, 1908; Precision Grinding, September, 1907; The Cost of Grinding, October, 1906.

† Address: Care of Brown & Sharpe Mfg. Co., Providence, R. I.

finished size. The guard A, Fig. 1, as it approaches the pawl D, serves as a gage to determine the extent to feed the wheel in. This operation takes a very short time and provides a smooth surface for the bronze shoes. This surface is so near the finished diameter that the shoes are not worn large before the work is reduced to the finished size, therefore the work is accurately and steadily supported during the finishing cuts. This is found particularly advantageous on hardened work where a large amount of stock is left for finishing and where chatter marks are more apparent if the supporting shoes of the back-rest do not fit the work very closely. It is also found to be a great saving on the wear of the shoes themselves.

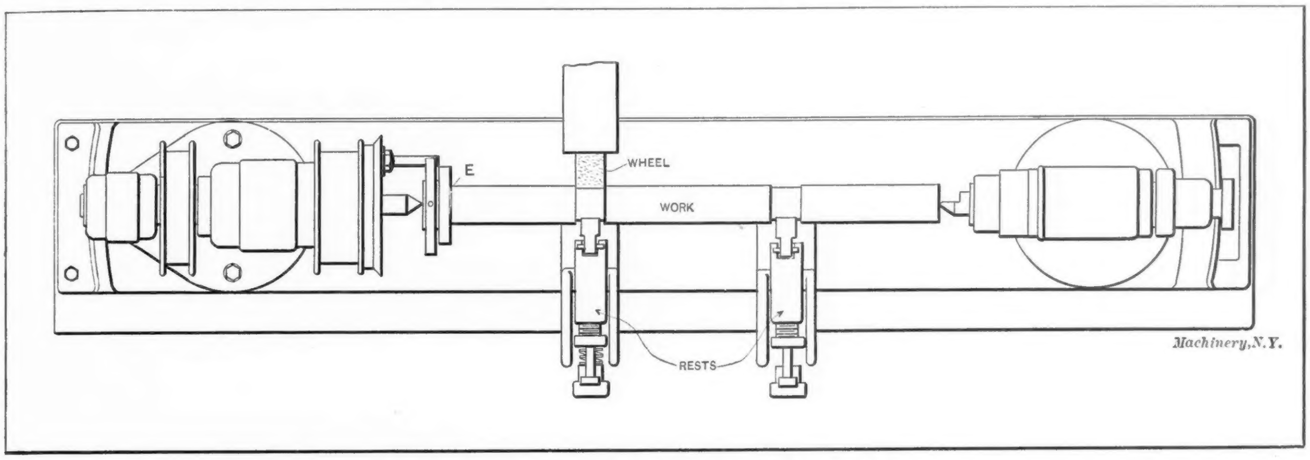


Fig. 2. Plan showing Method of Spotting Work for Back-rests

Grinding to a Shoulder

A time-consuming error among grinder operators is made on account of the prevalence of the idea that the reversing dogs on a grinding machine should be set to reverse the table traverse when the grinding wheel is within a very few thousandths of an inch of a shoulder on the work as at E, Fig. 2. It is a fact that most grinding machines will reverse within one or two thousandths of the same place each time, provided the rate of table travel is not changed. The variation in the depth of center holes in the work makes it necessary for the operator to try the reversing of the machine by hand after placing each piece in position to make sure that the wheel will not gouge the shoulder as it would surely do if the center holes were a little smaller than in the piece previously ground and a close limit for reversing were used. There are two ways to prevent the wheel gouging the shoulder on the work; one is the adjusting of the reversing dog by the screw F, Fig. 1, for each piece ground, which is a time-consuming operation; the other and better method is to bring the shoulder on the work up to the wheel by hand (using handwheel C after spotting for the back-rests as described), then feed the wheel straight into the work, reducing the diameter next to the shoulder for a distance equal, of course, to the width of the wheel, to the finished size. This is quickly and easily done by using the knock-off shield A against the pawl D for a gage as described. The table may then reverse for the subsequent complete grinding of the piece when the wheel has advanced not closer than 1/8 inch or more from the shoulder, and the edge of the wheel next to the shoulder does not become worn away or rounded because it runs off the work, or nearly off, at each end of the piece. A wasteful truing off of the wheel is thus easily avoided.

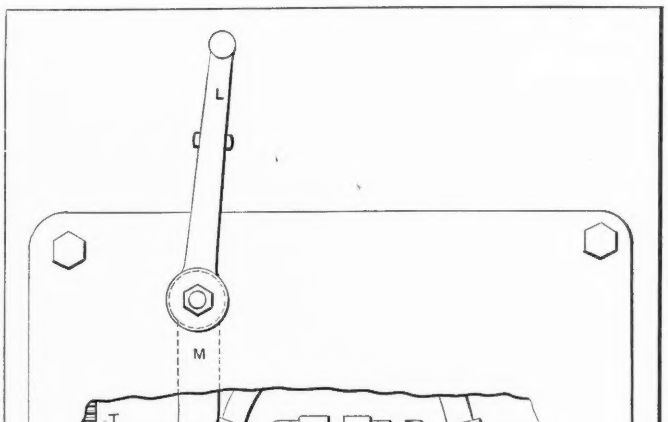


Fig. 3. Reversing Mechanism of the Brown & Sharpe Grinder

This operation of necking the work at a shoulder with the full width of the wheel, obviates the necessity of a dwell of the table at that reversing point. If a machine dwells when reversing at the shoulder end of the traverse, it must of necessity dwell at the other end where the wheel usually runs nearly off the work; here the dwell is not only of no value but it is very likely to cause the wheel to grind the end of the work undersize. While this dwell is only momentary, it is quite a factor in a day's output that can be readily eliminated.

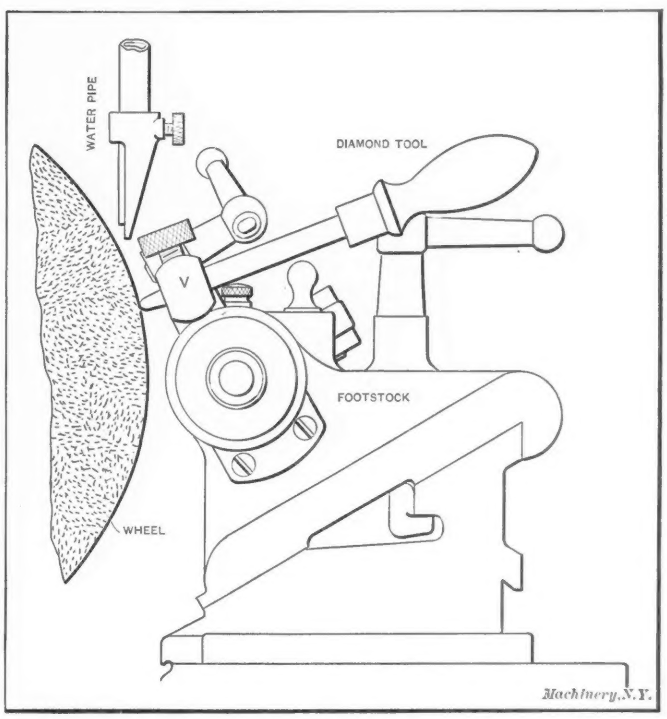


Fig. 4. The Way the Diamond Tool should be mounted for Truing the Wheel

If for any reason the necking of the work with the wheel is not deemed expedient and a dwell is required, this dwell is needful only once or twice during the grinding of a given piece and can be produced at will by the operator pressing the knob H, Fig. 1. Pressing this knob stops the power traverse

of the table, which may then be fed over by hand, using handwheel C, to face up the shoulder, and the dwell may be prolonged to allow one or more revolutions of the work as the particular quality of work and wheel may require, instead of the length of dwell being dependent entirely on the speed of the reciprocating table, as is the case when the dwell is automatically supplied by the gearing of the table. The table traverse is started after the dwell by pulling the knob H to the position shown in Fig. 1. A dwell so produced is not duplicated at the other end of the work except at the will of the operator.

It should be clearly understood that a grinding machine can be reversed with the shoulder on a piece of work ⅛ inch or more from a grinding wheel, then stopped at the reversing point and "forced over" this ⅛ inch or more beyond the normal reversing point without disturbing the reversing dogs and without subjecting the reversing mechanism to any strain.

In Fig. 3 are shown the elements of the reversing mechanism of the Brown & Sharpe plain grinders, which shows quite clearly how this traverse beyond the reversing point is accomplished. When the reversing dog J or K, Fig. 1, strikes and reciprocates the reversing lever L, the motion is transferred by its fulcrum stud and lever M to the arm N which compresses the reversing spring O. When this arm, which compresses the spring, has moved far enough to give considerable tension to the spring, the taper lug on the arm N raises the latch P thus releasing the yoke R which is connected to the reversing clutch S, this deriving its power from gear T. The spring, which is under compression, throws the reversing clutch as soon as the latch releases the yoke R. This movement of the yoke is sufficient to relieve the compressed reversing spring so that the reversing lever can traverse farther than the position where reversing takes place without unduly compressing the reversing springs. Thus the facing up of a shoulder on the work slightly beyond the reversing point without disturbing the reversing dogs on the sliding table can be readily accomplished without undue strain on any part of the reversing mechanism.

Truing the Wheel

When truing the periphery of a grinding wheel for all regular cylindrical work, a bort diamond, mounted in a suitable holder, is used, as shown in Fig. 4. This holder should be so mounted in its support that the distance from the diamond to the support V is as short as possible, thus avoiding spring or vibration in the holder which produces an irregular surface on the grinding wheel, appearing on the work in the form of a mottled effect or chatter. When work of large diameter is being ground, the wheel should be brought forward to the position shown in Fig. 4 when truing it off. The time consumed in moving the wheel forward with the cross-feed handwheel, is more than offset by the more rapid cutting of the wheel by the diamond, and, furthermore, the surface of the wheel is in better shape as stated.

For internal grinding, it has been proved economical by practice to true off the grinding wheel with a piece of a large wheel that has been worn down to such a small diameter as to render it useless for grinding; this piece of wheel must be harder than the wheel being trued off. This is a much quicker process than using a diamond, as the piece can be held in the hand and pressed to the grinding wheel as often as occasion requires. For this same purpose, bricks of various abrasive materials have been made and are generally used when pieces of a worn-out wheel are not available.

Design of the Footstock

The footstock of the grinding machine is of enough importance to warrant more attention than is generally allotted to it. The design that is in common use among grinding machine manufacturers, includes among other elements what might be called a spring-actuated spindle. The spring, which forces the center against the work, is primarily for the purpose of allowing the work to expand from the effect of the heat developed in grinding. As heat is very largely dissipated by the use of water, the more practical value of the spring-actuated footstock is to apply a firm pressure of the center against the work without force sufficient to distort it. This is very difficult to do with a screw and handwheel and is accomplished on a lathe by setting the center solid against the work, and withdrawing it until the work can be easily turned by hand. This represents a looseness between centers intolerable on a grinder and also causes a great waste of time. When grinding heavy work, there are two reasons why it is often necessary to clamp the footstock spindle solid after inserting the work in the machine. The weight of the piece of work tends to crowd the footstock center back on account of the angle of the center; also the momentum of the piece when the table reverses at the footstock end of its traverse tends to pound the center away and any looseness thus developed will render futile any attempt to produce round work.

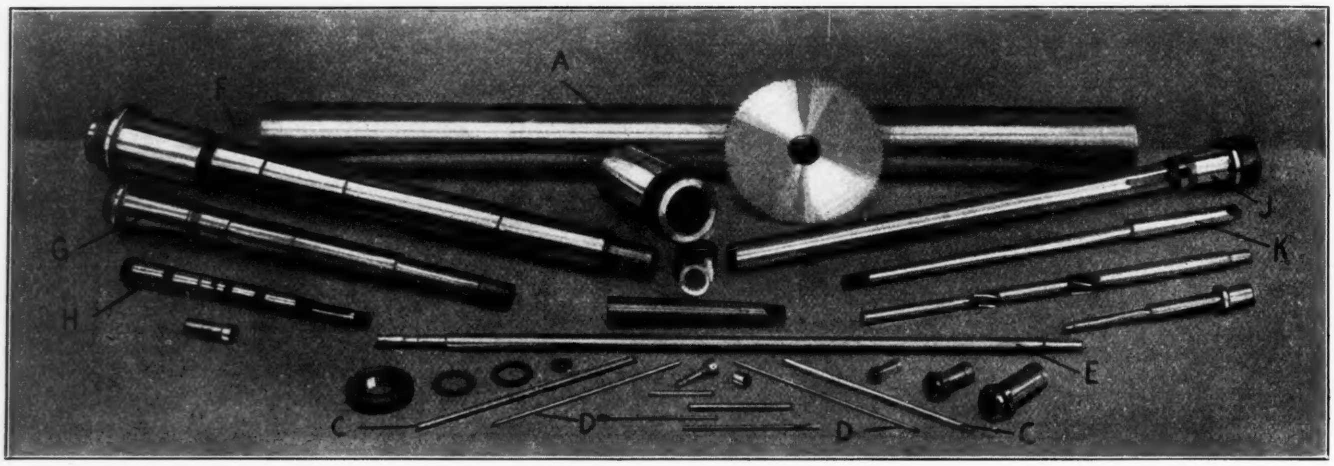


Fig. 5. Examples of Ground Work

Time Required for Grinding

In Fig. 5 there are shown several samples of work that has been finished on the grinding machine. Without exception every piece has been machined complete before it is sent to the grinding department; all threads have been cut, keyways and slots milled, holes drilled, etc., therefore all external and internal strains have been equalized in the pieces before they are ground. The grinding process is the most free-cutting process known to metal workers and should be the last cutting process as it distorts the work the least. The piece marked A is an overhanging arm for the milling machine, made of machinery steel 4½ inches diameter and 69 inches long. These pieces require an exceptionally good finish and are ground complete in thirty minutes for each arm. They are revolved in the grinding machine by a pin temporarily driven into one end near the periphery, this pin engaging the driving arm on the headstock pulley; with this arrangement pieces of sufficient size can be ground from one end to the other complete, while such small pieces as those marked C and D must be turned end for end to complete the grinding. These last pieces are about ½ and ¼ inch diameter, respectively, and 10 inches long. They are ground at the rate of fifteen

per hour and have a limit of 0.00025 inch either side of the dimension given. The shaft marked *E* is about 40 inches long and 1 inch in diameter where it is ground; this piece can be readily dogged at one end. These are ground at the rate of twenty minutes each with a tolerable variation of 0.00025 inch larger or smaller. The tapered collet shown in the center of the engraving is ground in four minutes. The milling machine spindle marked *F* is ground complete in one hour. The limits are very close, *viz.*, 0.00025 inch total variation, and the taper behind the collar is ground to a gage. The smaller spindle marked *G* has the same close limits as the larger one, and is ground complete at the rate of seventy in sixty-four hours. The spindle marked *J*, which is 34 inches long, has a threaded guard over the end and on this guard the dog is clamped. Thirty-nine of these spindles are ground complete in thirty hours. The screw machine spindle marked *H*, is a very difficult piece to finish owing to the fact that it is bored out its entire length so that it is practically a hardened steel shell which is cut away at the smaller end. When grinding these spindles in large lots, they are roughed out all over in large quantities then finish-ground later. It requires thirty minutes to completely grind one spindle.

This last example illustrates very clearly how difficult it is to estimate the time required for grinding a piece of work, as every feature of the piece enters into the problem and if it were not for the two slots which so cut away and weaken the small end that the grinding wheel cannot be forced into the work, these spindles could be ground in about ten minutes less time for each one. Placing the work on an arbor for grinding, very seldom increases the total length of time to grind when there are several duplicate pieces in a lot, as two arbors may be employed and the operator can insert one arbor in the work while the machine is grinding the work mounted on the other arbor.

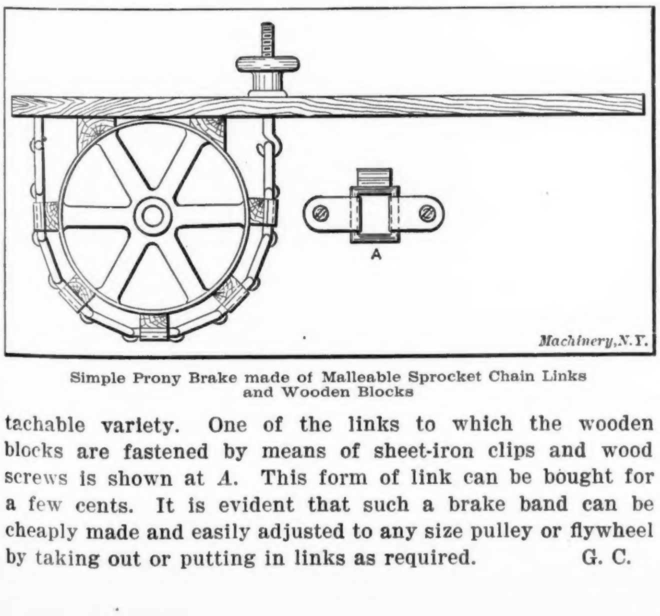
Number of Operators

The economical operation of a grinding machine presents very varied problems. It is sometimes an advantage for one man to run two machines; this is generally on long pieces where the time of actual grinding far exceeds the time of placing the work in the machines. There are, however, some jobs where two men can work very successfully on one machine. This is the case with short, large bushings that are driven on an arbor, in which case the time of changing the arbor from a finished piece to an unground piece equals or exceeds the actual time of grinding. When these conditions exist, the operator and the machine are non-productive at least half of the time, and this non-productive period can be reduced to a minimum by a helper to assist the operator.

* * *

AN EASILY MADE PRONY BRAKE

The accompanying sketch shows an easily made and cheap prony brake, suitable for testing gas engines, etc. The drawing requires but little explanation. The band is made of common malleable sprocket chain links of the ordinary de-



Simple Prony Brake made of Malleable Sprocket Chain Links and Wooden Blocks

tachable variety. One of the links to which the wooden blocks are fastened by means of sheet-iron clips and wood screws is shown at *A*. This form of link can be bought for a few cents. It is evident that such a brake band can be cheaply made and easily adjusted to any size pulley or flywheel by taking out or putting in links as required. G. C.

THE DETAIL ENGINEER

By GEORGE P. PEARCE*

The Novelty Works had the opportunity to supply some small finished pieces at a certain contract price. The price was low and the profit on each piece would be small, but as there would be thousands of pieces ordered and the deliveries would not be rushed as long as shipments were made in reasonable time, the shop could work on the order to "fill in," and this alone was an inducement. The owner and superintendent carefully looked over the sample piece and concluded that it could be made for the price, with enough profit to make it worth while. To be more sure they called in Bill, the machinist who should do most of the work, and he looked over the piece and thought that in hundred lots the time would average one hour each. This seemed reasonable, and without the slightest misgivings the contract was closed.

On the first hundred castings the time records showed two and a half hours each. The boss sent in a "hurry-up" call for the superintendent and asked "how about it?" The superintendent explained that it seemed as if that particular lot was "hoodooed," for although everyone worked like "blazes," progress was slow; however, this was the first lot, and, of course, it took time to watch and figure out the quickest methods; the next hundred certainly would show considerable improvement.

The second hundred were made in exactly two hours and eleven minutes each. The boss told the superintendent that something had to be done, for at this rate he would lose thousands of dollars. The superintendent tried other men and rigged up jigs and fixtures of all kinds, but could not get the time lower than two hours and five minutes. The boss then "personally" saw one hundred through, and stirred up so much excitement and hustle that the time ran up to two hours and fifteen minutes each. By now it was settled in the mind of the boss that he was "caught for fair," and he wondered how much he could break the contract for, as it evidently was impossible to keep on in this way. He thought of sending for Mr. Wm. Steelworth, the detail engineer, to see what he could do, but then surely it would not be possible to cut the time on the work any lower, for had he not made every man work so hard on one lot that they could scarcely walk home, and he did not believe any man could drive them harder. The superintendent was of the same opinion, but he had heard such good opinions about this man that he suggested giving him a trial.

When Mr. Steelworth arrived, the boss took him in his private office, told the whole story, and expected that Mr. Steelworth would offer his suggestions and remedies there and then; but no such thing happened. He simply said that from what he had been told it seemed quite a proposition, but he wished to go right into the shop where he could observe all conditions and study out his own solution. This was unexpected, as the boss had supposed he would outline his plan of campaign and submit it for approval, and, if satisfactory, he would then be allowed to adopt it and possibly "see it through." The boss never allowed anyone to try anything new in the shop without his approval; however, he decided for once to break this rule, and Mr. Steelworth went into the shop.

The first move was a trip to the pile of castings, and the superintendent smiled at the length of time it took to look over the castings; nor could he see the need of examining so many, for three or four should tell the story of how they were "running." After this came a more leisurely examination of the different jigs and fixtures. There was one thing that rather rattled the superintendent. After he had minutely described every operation, how the castings were chucked and the different tools used until the finished pieces were passed to the inspection and shipping department, Mr. Steelworth persisted in following a set of castings through the shop, "counting every time a man breathed," as Bill had said. This made the men ill tempered, and they were telling one another what a "man driver" he was going to be.

The next day Mr. Steelworth asked the superintendent that aluminum patterns be made to replace the wooden ones. Both

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the boss and the superintendent explained that this was quite unnecessary, the wooden patterns were accurate and good enough, and lighter than anything else; and, anyhow, on these small pieces, weight did not count. But Mr. Steelworth said it had to be aluminum patterns or he would go no further; besides this, he wanted that central cored hole done away with, and a solid casting made instead. This meant the addition of three-eighths pound of metal and looked as if instead of reducing he was planning to increase costs.

The aluminum pattern castings were made, however, and were cleaned up, ready to send to the foundry, but Mr. Steelworth wanted the patterns machined all over and the machine marks buffed out. The superintendent thought this was going too far, and sarcastically remarked that they did not get castings with buffed surfaces and that a reasonably smooth pattern would draw well and be "good enough." Mr. Steelworth observed that he wanted these this way. After several trials, the men got the patterns smooth and accurate enough, and they were passed on to the foundry. Mr. Steelworth saw the foundry foreman, with the result that the next batch of castings was to be well pickled.

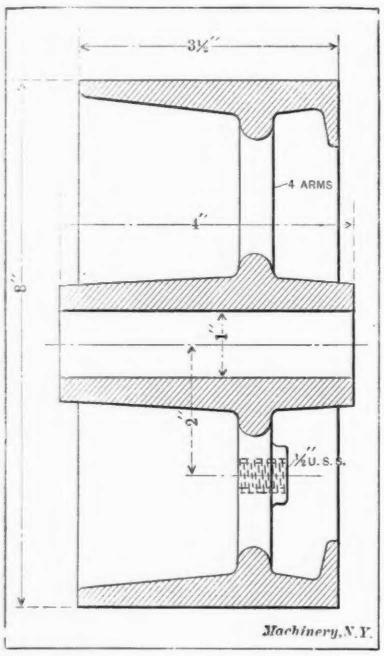


Fig. 1. Drawing of the Piece to be made

While waiting for the castings Mr. Steelworth picked up a big chunk of cast iron and had Bill fit it on the lathe nose; the front end was faced and holes were drilled and tapped so the casting could be quickly clamped to the face; the chunk of iron was also rough turned true. Soon the castings came in and a rusty looking lot they were in comparison to the nice "faced" ones that had previously been used. Bill was to machine them, and he quickly spotted that the central hole was not cored, at which he "cussed," for it meant a drilling job before he could bore them. He also had a few words to say about making the ungainly chuck, when he could catch them in the four jaw chuck and hold them just as well, besides having a better chance to true them up. His soliloquy was cut short by the arrival of Mr. Steelworth who said they would start in on the castings. "*They*," Bill muttered. "Is it going to take two men to do the job now? 'Cut time' indeed." The first thing Bill was told to do was to put the "chunky-chuck," as he called it, on the lathe nose, and then step the end of it down so as to be an easy fit in the large recess at the back of the casting. This he did and the casting slipped easily into place. Bill started for his monkey-wrench to tighten the cap screws which clamped the casting, but Mr. Steelworth stopped him and handed him a handy little ratchet wrench.

"*We'll* have to drill a hole through it before I can bore it," remarked Bill.

"*We* won't bore it at all, but will drill it small and ream it," remarked Mr. Steelworth. Get a twist drill, 1/64 inch small, and a dog." Just as Bill came back with these things, the whistle blew, and further work was postponed until after dinner.

Bill was back early and went to the superintendent as soon as that worthy appeared.

"Say! I don't want to interfere with any of your plans, but I'll be darned if I want to ape the green hand to instructions received from Mr. 'Great Ideas.'"

"What in the world has happened now?"

"Well! I don't mind clamping those castings to a piece of junk instead of the proper chuck, but when it comes to expecting castings to slip over shoulders, as if two castings ever came to within a strong sixty-fourth, and then having to drill the hole with a twist drill and ream it, as if a hole could be drilled central with a twist drill scotched by a dog, and there is no need for a reamed hole anyway. Besides this, goodness knows how much more time-wasting foolishness is coming, and it certainly is not going to be Bill who will deliberately waste castings and time to the tune of a "know nothing."

"Well, Bill, I have been noticing things myself and have talked it over with the 'old man,' and we decided to let it run this afternoon and let Mr. Steelworth trip himself on the time limit."

With a grunt Bill went and got a hammer and "round nose" to chip the start for the drill, but Mr. Steelworth arrived before he got started and told him to leave the hammer and chisel alone, and taking a tool holder, he ground the tool a kind of a cross between a facing and hogging tool which enabled him to take a quick facing cut right across the boss and then turn a countersink almost as large as the drill; he next put the drill against the tailstock center with the dog resting on the tool-post block and the heel of the tool touching the drill close to the cutting end, so that it could not run out. The lathe was speeded up way beyond what Bill generally ran it for similar work, and the drill fed in with a good heavy cut which was kept up right through. As the drill changed its "growl" when the point went through, Mr. Steelworth brought the flat part of the tool-holder against the dog and forestalled the drill's "hogging through" and twisting everything out of shape by snatching off the tail-center. Bill felt a little disappointed, as he had anticipated a broken drill, but still he smiled, for had not Mr. Steelworth ground the drill by hand in a few seconds and only sighted it up, and everyone knew it was quite a job to grind a drill so it would drill its own size and no larger. Besides he knew the drill was "loose" by the easy way it came out. He was disappointed again, for although the drill was not drilling to size, the hole was not quite a sixty-fourth out and this oversize really helped, for it only took a few seconds to put the reamer through. The drilling and reaming time was five minutes.

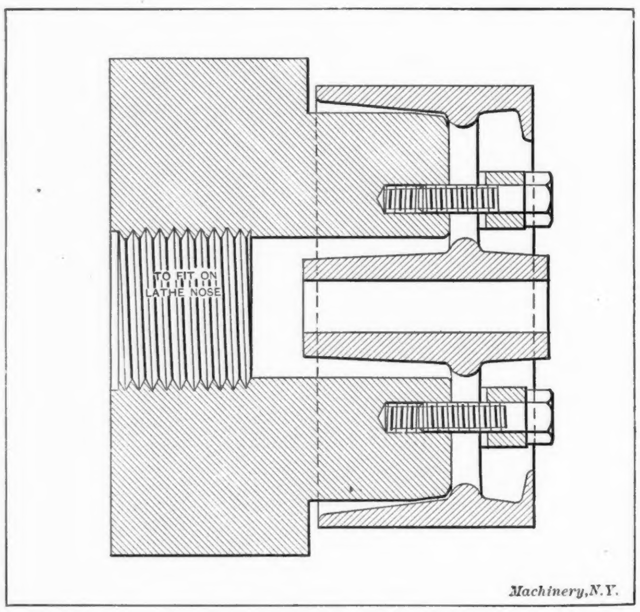


Fig. 2. Method of Chucking

Next Mr. Steelworth told Bill to take the casting out and put it on the tray at his right hand, then twist round and pick another from the tray on his left and put it on the chuck without moving his feet. Bill had some personal thoughts about such detailed instructions instead of saying "change castings"; and whoever heard of taking an unfinished casting out after once it was chucked; however he did according to schedule, and was surprised to find that the next casting went on all right; it was not often that two castings came so near. The facing, countersinking, drilling and reaming were quickly done, and ten were done in fifty minutes with only one casting refusing to go on the chuck, the only trouble being a little

snag which was quickly knocked off with the butt end of a lathe tool. Mr. Steelworth asked Bill if he thought he would have any trouble in keeping up a twelve per hour rate and Bill thought it would be easy for he had not hustled any above keeping right at it.

The next thing was facing the two sides as far as they reached down. Mr. Steelworth brought an old sleeve coupling up to the lathe and put it on a block so the top of the coupling was about 30 inches from the floor. Then he took a short mandrel he had picked out of the "pile" and drove it lightly in the casting; next he took a heavy dog about three sizes too big for the mandrel and, to Bill's amazement clamped it on the driving plate, which he had put on the lathe, with its tail sticking outward. He put the mandrel on the centers, and then the convenience of the arrangement became apparent for the tail of the dog reached into the casting plenty far enough to catch the arm in the casting. Bill inwardly chuckled, for he knew that some of the castings would go further on the mandrel before they became tight, and then where would the dog drive be? Next Bill was told to get another tool-post, tool-holder and two tools which were fastened in the tool-block, one tool having been ground right hand and the other left. They were spaced the required distance, and were quickly fed across the side in one cut, thus facing both sides at once. It was but a moment's work to take the job out of the centers and put it on the sleeve; one quick blow with a soft hammer drove out the mandrel. As a block of wood had been placed in the sleeve, the mandrel just fell far enough to be loose in the casting, and was easily picked up with the left hand while another casting was picked up with the right and placed on the sleeve, the mandrel being placed in position while the free right hand was picking up the hammer. The mandrel was driven in by two light blows, and the job put in the lathe, when to Bill's surprise the dog tail just reached in to about the same distance. While he was facing the two sides Mr. Steelworth explained that as all the castings had reamed holes, they come tight enough in almost the same place on the mandrel if driven with about the same force; if Bill had any doubts as to being able to hit every time the same, he could easily mark the mandrel and drive as far as the mark—there was no need for the job to be very

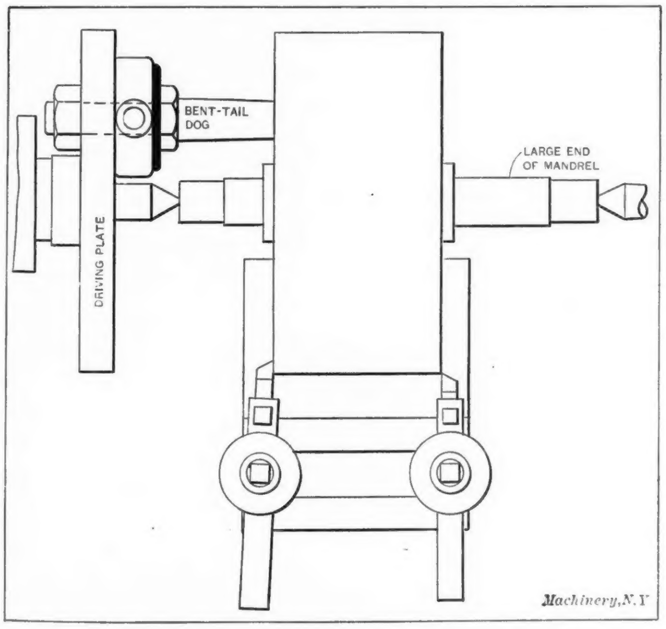


Fig. 3. Method of Driving the Work when Facing the Sides

tight, as it was not driven by the mandrel. The time for this operation was four minutes.

The next thing was turning the outside diameter and for this the two tools were again used, one set nearly to the required diameter and the other to take a light finishing and sizing cut. They were placed a little further apart than the width of the job so that both would not be cutting at the same time. The work was driven in the same manner as when facing. This operation Bill told the boys he knew how to go one better, and cut the time almost in two by placing the two tools close together so that it would only be necessary to wait the length of time for a little over one cut, instead of over two cuts. The first time he had a chance he tried it. The fellows thought Mr. Steelworth must have been slow, until the moment the roughing tool got across and the finishing tool immediately changed its cut enough to prove that the roughing tool had been springing the work, and, of course, the finishing tool had no chance to even up this inaccuracy. Thus the "improvement" fell through and Bill was glad to find that

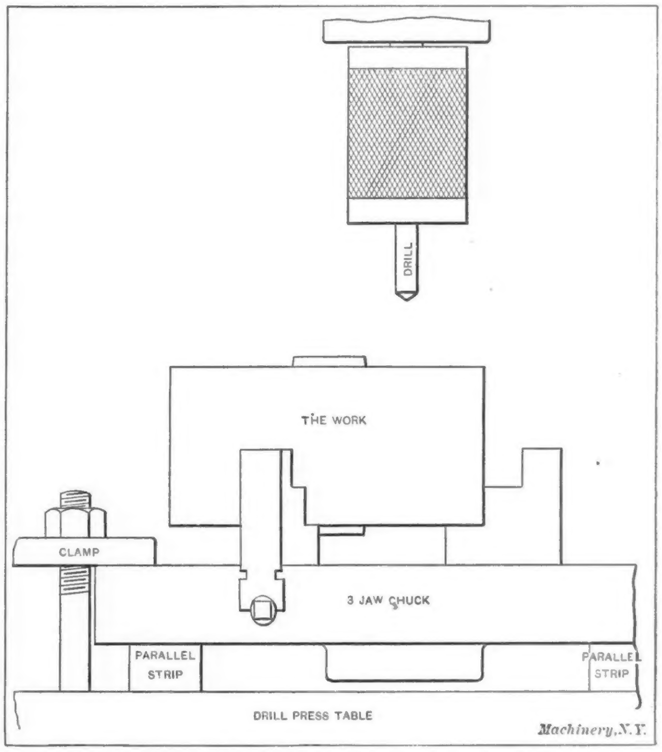


Fig. 4. Method of Holding the Work for Drilling and Tapping

another cut across saved the casting. In the future, Bill was always very careful to try things before he chased around saying what he was "going to do." The roughing and finishing cuts and changing took eleven minutes.

Next, there were the bosses to be faced to the right thickness in relation to the sides. This time the work was driven tightly on the mandrel and the two tool-holders provided with tools ground what Bill termed "right- and left-hand parting," which came as near as anyone could suggest; these were set oversize for roughing, and one of the tool-holders so twisted that when the body of the tool nearly touched the finished side of the job it would leave nearly one thirty-second of stock to be removed in finishing; of course both tools were set to reach the mandrel simultaneously. When once set up, it proved a very quick method, as four minutes each, including changing, was the average time. Bill supposed that the bosses would have the finishing cut taken in the same way, but Mr. Steelworth said that for this job it would be better to finish them on the drill press. Here the table was nicely cleaned and two parallels clamped on it so the work could lie on its finished sides and be clear of the table. A counterbore was put in the chuck and the stop collar set so as to face the boss to the exact height. Bill was instructed to let the counterbore make two or three revolutions after the collar reached the stop so as to put a nice bright finish on the boss, but not to leave it running longer than that, as it would tend to dull the cutting edges. By having the box of unfinished pieces on the left and moving from left to right, Bill was able to change and face at the rate of one per minute, or two minutes for the two bosses.

Next there was a hole to drill and tap. For this Mr. Steelworth picked up a three-jaw lathe chuck which he placed on the drill press table. In this he clamped the casting so that the hole to be tapped would come about central with the hole through the chuck body, which was carefully located under the center of the drill chuck and clamped there. Then he took an old broken drill stub which he carefully ground and also thinned the point, there being enough twist left to get

the chips out before the drill went through. This was placed in the drill chuck, and the drill press head moved down until the drill could only be lifted high enough to clear the work when it was changed. While this was being done, Mr. Steelworth had set Jimmie at work to roughly grind the castings where the drill would enter, as the place could be easily reached by the emery wheel. Mr. Steelworth said it was better to grind off the scale in this case than to have to grind the drill too frequently; besides it would allow the drilling to be done at a much higher speed than if it had to drill through the scale first, and it would not pay to keep changing the speed on this short hole. Jimmie ground four per minute and Bill drilled them at one per minute, using the power feed which Mr. Steelworth insisted upon, not because it was quicker, but because it was sure to keep the drill under a good cut all the time, and not let it scrape round without cutting and grind off the edge.

The superintendent came along at this time and nearly had a fit when he saw the drilling layout; he politely asked Mr. Steelworth what was the matter with the drilling jig he had had specially made for this operation and which cost over $50.00. Mr. Steelworth said that there were three things about it that made it an unprofitable tool; first, the hinged cover was tightened by two swing bolts with wing nuts which meant six actions in changing pieces, and the drill had to be raised nearly a foot more than necessary to let the lid open up or else the jig had to be pulled to one side and then located again; second, the casting was located on the bottom of the jig, and while there was a fairly large opening in the base it was not large enough for all the chips, and they would get onto the locating surface when the job was changed; thus the man would have to be constantly cleaning the jig which would use up quite a little time; and third, the jig was absolutely unnecessary, anyhow, as the three-jaw lathe chuck located and held this particular piece better than any jig, and it was only necessary to swing the wrench handle one-third turn to open the jaws enough to release the job, which meant only two short actions to change jobs. The very construction of the three-jaw chuck meant freedom from chips and chip troubles; the drill did not need to be raised much over an inch to change jobs; and the stub drill and close drill head meant that the hole would be drilled well within the requirements of the work. The superintendent passed along and thought that perhaps after all the jig and fixture craze is in many instances overdone.

Bill told Mr. Steelworth that they had always tapped the hole by hand, as it did not take long to catch the piece in the vise and run the tap through, and it saved the time for clamping in the jig, the broken taps, and backing the tap out. He also wished to point out that the wrong size drill had been used for the hole; why, it was almost a thirty-second larger than the size called for in the table, and he pointed out the "diameter at root of thread" in his pocket-book. This seemed to squelch Mr. Steelworth, for he meekly asked for the tap and a socket wrench to loosely fit it. Bill knew he meant "tap wrench," but he brought a "socket" and grinned as he waited around. Mr. Steelworth certainly was completely tangled up by now, for instead of putting the work in the vise he put the socket wrench there, and then, apparently not knowing what to do, he picked up a hack-saw and deliberately sawed the "socket" off. He then put this in the drill chuck, and, slowing the drill press down, he put the tap in the square hole and held it there while he brought the drill head down and followed the tap right through the casting that had been left in the lathe chuck. Just before it dropped through the hole, he placed his hand under the table and caught it. One minute each was ample time for tapping, and Bill never mentioned hand tapping again. The pieces were now finished, the actual working time on each being twenty-eight and a quarter minutes. Mr. Steelworth asked Bill if he could keep on making them at this rate, and Bill said if things went along as smooth as they had that afternoon he was sure he could, but he never knew a set of castings to be cast so near, machine so easy, and work along with so little trouble as this lot. Mr. Steelworth said he did not think there would be any more trouble with hard or sandy castings; however, he made the time rate thirty-five minutes each, which enabled Bill to earn more money in the next eighteen months than he ever had before.

The boss and the superintendent were both in the private office waiting, for it was now nearly an hour after quitting time. The superintendent had told the boss the surprising news that ten castings had been put through that afternoon, and how he had secretly taken one and carefully measured it up and found it extremely accurate and nicely finished. When Mr. Steelworth came in, he was received with a smile. The boss spoke first:

"How long do you find it will take to machine those castings?"

"Your man Bill will gladly take them on piecework at thirty-five minutes each."

"I am real glad to hear that, as it will change thousands of dollars loss into thousands of dollars profit. But Bill must have had a great change of ideas this afternoon, for this morning he said no man could make them under two hours each."

"Well I should say Bill was right when working under the handicap that he has been."

"Mr. Steelworth, you would do myself and my superintendent a great favor if you will explain what you found wrong with our method of getting those castings machined, for it seemed to us to be the only right way, and surely our method of finishing each is standard practice."

"I know nothing about 'standard practice.' The failure with your method was that not enough attention had been given to details—the little things. The castings were made from wooden patterns with loose bosses, the patterns had warped, loosened up a little at the joints, and the loose bosses kept getting sand under them with the result that the castings were crooked and had tilted bosses. The chuck jaws would always pull the boss straight and throw the edge of the casting out, so the man had to put wedge pieces under half the bosses to make the casting run nearly true. Then the molds were faced, and while the castings were good looking, they had a chilled scale that took the edge off the tool in one cut, even running at the lowest speed. Then the man had to carefully caliper to get the sizes; all this measurement had to be repeated for each piece, as he changed tools every time. Besides this, he fetched the castings from the 'pile' four or five at a time, which meant many trips; he kept them on the floor near the lathe and had to stoop to pick up each one; every one as it was finished on the lathe was carried over to the drill press and placed on the floor near it. The lathe tools were placed on the lathe tool stand and mixed with the others, thus taking a little extra time to pick them out again, the drilling was done onto the hard scale, the drill was too small for tapping in cast iron, and the tapping was done by hand, it being necessary to change the taps in tapping on account of the small hole; in fact it was a minute here, a few seconds there, and a continual waste of time throughout the whole operation. This combined with the attempt to apply turret lathe methods to a common engine lathe on a job that was not suitable, all helped to consume over two hours on a half-hour job. All I have done has been to attend to the little details that often seem to be too small to be worth paying any attention to."

Both the boss and the superintendent said it was absurdly simple, but it had never been so thoroughly brought home to them before that the minute here, the second there, the short trips across the shop for wrenches and the "hunting" for tools made all the difference between success and failure. They were extremely grateful to Mr. Steelworth and the boss never asked him how much his services were but passed him a check that was over twice the amount he intended to ask.

* * *

The progress of aeronautics is indicated by the fact that the aviation department of the Motor Supply Co., Ltd., of London, England, has published a catalogue of aeroplanes containing full description and prices. The Bleriot monoplane can be had for about $2,500, and a Farman biplane for from $4,200 to $5,500, the price varying considerably according to the engines provided. The Santos-Dumont monoplane may be bought for a mere $1,500, while the Wright machine commands a price of from $5,500 to $6,000.

A FORMED TOOL POST AND A RECESSING TOOL FOR SCREW MACHINE WORK

In Figs. 1 and 2 are shown a couple of screw machine tools which have been found to be very convenient in screw machine work by the Colburn Machine Tool Co., of Franklin, Pa.

The first of these is a recessing tool of simple but rigid construction. The body of the tool comprises a shank, fitting the hole in the turret, and a head having a T-slot milled through it, to form ways for the slide carrying the boring tool which is to do the recessing. This slide is operated through a small movement by means of the handle shown. The handle is screwed into a plunger fitting a hole in the shank, and having an eccentric diameter at its outer end fitting a cross-slot in the tool-slide. By this means the rocking of the handle gives the

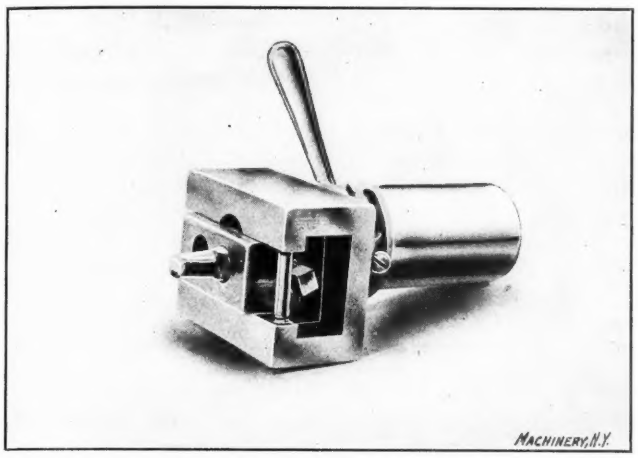


Fig. 1. A Convenient Recessing Tool for Screw Machine Work

desired movement to the tool. To limit this movement in the outward direction, to give a desired depth of recess, a slotted circular stop is provided, adjustably clamped to the side of the shank, as shown, for the handle to strike against. By adjusting this up or down, the depth of recess is changed to suit.

The T-slot in the head for the tool-block is strengthened by screws passing through from one side to the other, one of which can be seen at the front. Two holes are provided for the boring tool with which the recessing is done, thus increasing the diameter range of the device; this range is for diameters from 0 to 2½ inches. The tool is held in place in the

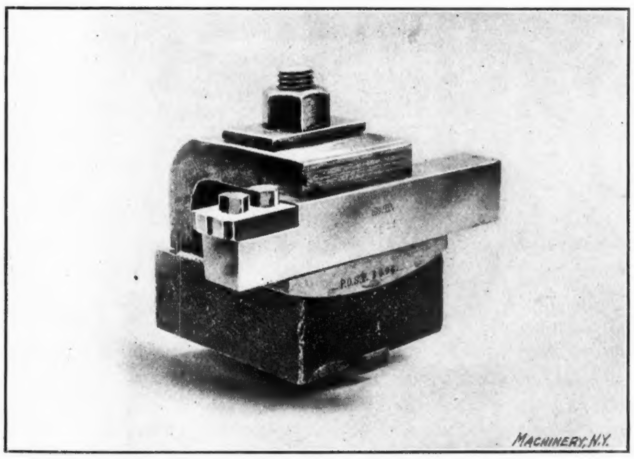


Fig. 2. Separate Blade Formed Tool, with Open Faced, Rocking Holder

socket by the set-screw shown, which is screwed into the other end of the tool-block when the other hole is used.

In Fig. 2 is shown a formed tool and holder of considerable interest. This firm follows the practice, on ordinary work, of making formed tools for use in the screw machine out of comparatively thin plates of tool steel, screwed onto a soft steel holder or shank. This method greatly reduces the amount of costly tool steel used. It is also quicker and easier to produce the desired outline on a thin blade, than it is on the end of a large tool-block of solid stock.

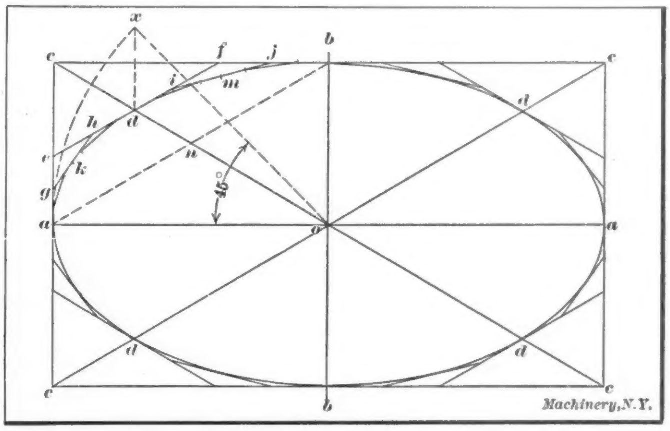
The formed tool-holder permits rocking the tool-blade up or down to get the proper center distance, and in addition has the advantage of holding it in such a way that it may be operated close up to the face of the chuck, as it is of the open-faced type.

The shank of the formed tool is set on a circular rocker, as shown, of a type similar to that used for the ordinary tool-post. The strap by which it is clamped is bent down at the rear end to rest on the bottom of the tool-block. The bearing at this point is also circular, on a radius struck from the same center line as that of the rocker under the tool. Furthermore, the rectangular washer used under the nut on the clamping bolt, for drawing down the strap against the tool, is seated in a similar cylindrical surface in the top of the strap, turned out to a radius from the same center line. It will thus be seen that, by loosening the clamping nut slightly, the tool rocker and strap may all be swung one way or the other, to raise or lower the point of the tool, without disturbing their bearings on the tool-block, or the bearing of the washer on the top of the strap.

* * *

SIMPLE METHOD OF DRAWING AN ELLIPSE

In the February 24 issue of the *Engineering News*, Mr. G. W. Colles gives a method for drawing ellipses which is very simple and convenient, and which, therefore, will undoubtedly be of interest to draftsmen and designers in general. Most methods only give points upon the curve, ignoring the fact that the *direction* of the curve at the point is fully as important as the point itself. The present method is based on the fact that every ellipse may be considered a strained circle, that is, one which is distorted in one or two directions proportionately at all points. The accompanying illustration



A Simple and Convenient Method of Drawing an Ellipse

shows the method applied. Lines *aoa* and *bob* are the axes, intersecting at *o*. Upon these construct the rectangle *cccc* within which the ellipse is to be inscribed. Draw the diagonals *cc*. Draw *ox* at 45 degrees to axis *aa*, making it equal to *ao*, and drop a line *xd* perpendicular to the axis *aoa*, intersecting *oc* at *d*, which is a point upon the ellipse, and the tangent *edf* is drawn parallel to *coc*. In small ellipses, the three points and tangent on each quadrant will be sufficient to enable the ellipse to be constructed satisfactorily, but for greater exactness bisect *ae* and *ed* at *g* and *h*, and *df* and *fb* at *i* and *j*; then the lines *gh* and *ij* will be tangent to the ellipse, and will practically draw the curve, but if this is still insufficient we may bisect *gh* at *k* and *ij* at *m* and again bisect *ag*, *gk*, *kh*, *hd*, *di*, *im*, *mj* and *jb*, joining the points of bisection to give further tangents to the curve.

* * *

According to a report from Consul Albert Halstead of Birmingham, a patent for improvements in typewriting machines owned by the Yost Writing Machine Co., of New York, has been revoked under the new British patents law. Not only was the patent revoked, but the company was ordered to pay the cost of the British applicant for the revocation, this cost amounting to more than $150. Under these conditions it is advisable for inventors and firms contemplating to secure patents in Great Britain when they do not intend to manufacture in that country, either to refrain from obtaining patents, or to be sure to confer the rights of manufacture upon some firm which will manufacture the articles in the United Kingdom.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

MAY, 1910

PAID CIRCULATION FOR APRIL, 1910, 26,453 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 300 pages a year of additional matter, and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

MONTHLIES

More than seventy-five per cent of the readers in the machinery industry in this country are readers of monthlies. The published figures of the two leading journals in that industry show their aggregate domestic circulation to be about 56,000, of which some 43,000 is monthly; and these figures do not take into account the circulation of the other monthlies.

There must be a reason for this preponderance in favor of the monthly, and the reason is that the great majority of mechanical readers obtain all the current information they have time to digest, in a monthly at the minimum cost and in the most convenient form.

These figures are not used to boost MACHINERY any more than the four other monthlies; nor to disparage the weeklies. Both are valuable, both are needed; the weekly for the commercial end of the business where the news and markets are required, the monthly for the mechanical end where practical information is essential—and everyone knows that such matter does not lose value by being published monthly.

* * *

FURNISH PLENTY OF CLAMPING DEVICES

Too much time is lost in the average machine shop "hunting" for suitable clamps, straps and screw-jacks, for fastening work to the faceplate of a lathe or the table of a planer or shaper. Unfortunately many superintendents have not yet realized the necessity for providing an adequate supply of these devices, which, though simple, are of the highest importance in turning out first-class work. In the interest of economy every shop should be equipped with a complete collection of such devices; a convenient central place should be provided for keeping them, and each man should be required to return them to that place after use. On many classes of work more time is lost trying to find suitable tools of this kind than is used in the actual performance of the machine work; and on account of inferior clamping and supporting devices, the work itself is often not as satisfactory when completed as it would have been if proper clamping facilities had been provided.

VARIATION IN GAS ENGINE EFFICIENCY

No doubt the article on the location of the gas engine igniter by Mr. Miller in the April number was read with interest—and some disappointment by those who expected to obtain definite information on this important subject. They learned, however—if not already aware of it—that the location of the igniter depends on a number of variable factors, and under common conditions no definite rule can be laid down for its location which will give the maximum efficiency for a certain type of engine. In fact it appears that the position of the igniter may often be varied in individual engines with resulting increase or decrease of efficiency. It also appears from our correspondence with the author that the horsepower developed by two engines of the same bore and stroke may vary considerably; for example, a nominal twenty-horsepower model developed from 17 to 22 horsepower in individual engines. The reason for this variation, according to a statement received from the author, is the position of the inlet valve, shape of inlet valve, size of cored passage at inlet valve, and particularly the shape of cored passages. All these factors affect the flow of the incoming charge. The author writes:

We were building gasoline engines in a certain shop, 8 inches cylinder bore, 16 inches stroke. One of these engines under brake test developed nearly 17 horsepower, while another made from the same drawings and patterns, exactly alike in all details, developed nearly 22 horsepower. These engines generally varied from 19 to 21 horsepower. A change in the position of the igniter on one of these engines resulted in its developing 24.4 horsepower. I claim from experience gained in building hundreds of these engines that the variation in horsepower is directly traceable to the cored passages of these engines.

If this experience proves anything, it shows conclusively the need of a reform in certain practices in gas engine construction. It shows the need of standardizing all parts and securing uniformity in sizes of passages. Perhaps this means more machine work and greater cost of construction, but surely such great variations in power and efficiency are not allowable in good practice. No doubt much of the inefficiency of gas engine performance, and resulting dissatisfaction, has been caused by variations in castings that were assembled with no machine work done where it ought to have been done, if the highest efficiency and uniform power rating were to be secured.

* * *

THE USE OF THE SECANT

There are eight regularly named trigonometrical functions, of which four (the sine, cosine, tangent and cotangent), are by far the most extensively used. In this country, however, we make considerable use of another pair of functions, the secant and cosecant. The secant is, of course, the reciprocal of the cosine. Tables for these functions are commonly given and are in everyday use here in America. In Europe the student is taught what they are, but no tables of secants and cosecants are published, and practical use is never made of them.

The reason for the difference in practice is probably a deep-seated one. The secant is useful in that it avoids, in numberless instances, the division of a simple integral number by an unwieldy decimal, permitting, instead, the simpler multiplication of the decimal by an integer. This refers, of course, to the use of natural functions only. With logarithmic functions there is not the same difference in favor of the secant, so the person who uses logarithms has no use for it. There are thousands of common everyday American mechanics using natural functions who have gone no further in their studies. For these thousands, tables of secants have been prepared, and rules and formulas printed which call for the use of these tables.

In European countries, on the other hand, the common everyday workman knows little, and cares less, about trigonometry. It is studied by comparatively few except those in the schools who take courses which include trigonometry, logarithms, and mathematical branches even more advanced. It is, therefore, on the whole a hopeful sign that the secant survives among us, when it has become in Europe of little more use than the vermiform appendix.

THE CANCELLATION OF MACHINE TOOL ORDERS

A subject which vitally concerns every machine tool builder—the cancellation of orders without forfeit—is to be discussed at the coming convention of the National Machine Tool Builders' Association at Rochester, N. Y. The difficulties of discontinuing this practice are obvious, and while it is doubtful if the discussion results in a practicable method of correcting the abuse, it will serve to focus the general attention of manufacturers on a practice which is not tolerated in any other industry, and it may result in some modifications of the present custom which will help the situation. Machine tool builders usually enjoy cordial relations with their customers and most of them will hesitate to adopt rigid conditions of sale that will offend good friends, and which if rigidly adhered to will allow many sales to pass to competitors who are not so scrupulous. But the practice of accepting orders from dealers and users for machines to be delivered several months ahead is often a sort of gamble in which all the risks are assumed by the manufacturer; because if any sudden drop in business takes place the dealers have little hesitation in cancelling the orders and throwing all the loss on the manufacturer; and the buyer is not always to blame, because he often simply accepts the terms urged on him by the salesman.

When orders are placed for machine tools they call for money to be invested in material, sometimes for equipment to be purchased, for the organization to be kept up to a certain strength and for outlay in various directions to make deliveries as promised; and the cancellation of such orders should be penalized in some reasonable proportion to the value of the machines. Machine tool builders who order pig iron for castings must take the iron no matter what changes have taken place in manufacturing conditions or in price in the interval before delivery. No cancellations are permitted; and so far as practicable buyers of machinery should be held to similar terms.

* * *

INDUSTRIAL EDUCATION AND THE SALES DEPARTMENT

Few people in the selling department realize the importance to them of industrial education. It doesn't attract them because it apparently doesn't touch their work; but they forget that mechanical ability in the men who construct the machines is as necessary to their sale as the foundation is to the building in which the selling department has an office. Imagine one selling organization representing a concern whose product is turned out by mechanics of the highest skill; and another representing a plant manned by "floaters" and half-educated machinists, with a superintendent and foreman of the same character.

Which organization would *you* prefer to represent, and why?

Perhaps you, who read this, are one of the big manufacturers who have given time and money to improving conditions which every thinking man sees will determine the future of our machinery industry; perhaps you are in the selling end of the business with only a slight interest in the manufacturing part. We say to you that whether you occupy a leading or a minor position, your future is linked with the prosperity of the macninery industry, and *that* is based on the mechanical ability of the workmen.

The reading of a gocd mechanical journal is an essential part of a mechanical education; but that isn't enough, and MACHINERY for several years has been building up a system for supplying inexpensive, but practical and authentic, material to mechanics who seek to educate themselves, and as a help to the various agencies which are pushing industrial education. We have at present about $60,000 worth of such material, and during the past year have sent out over 2,000,000 pieces of printed matter of an educational character. There are nearly 500,000 more-or-less skilled men connected with the machinery industry, and it takes a lot of material, systematically distributed, to reach them all, even occasionally. If you are taking no part in the work for industrial education, write us and we will suggest how you can help.

This isn't a money-making proposition.

MACHINING A GRINDER COLUMN AND KNEE

By ETHAN VIALL*

In the manufacture of a universal grinder, the Thompson Grinder Co., Springfield, Ohio, uses several interesting jigs and fixtures. The center columns, the shape of which is shown in Fig. 1, are first strapped, small end down, to an angle-plate on a boring mill and the large end is counterbored as at *A*; the casting is then reversed and set over a centering base-plug on the boring mill table, and the center hole *B* is bored out. From here the casting goes to a Fosdick radial drill, Fig. 3, where the two large holes in the base, one of which is for the elevating screw, are drilled and reamed. The jig used is shown more plainly in Fig. 4. The casting is centered by the counterbored base which fits over the turned bosses on the jig spider.

The planing fixture used to hold the column while finishing the V's, is as simple, yet as complete and mechanically

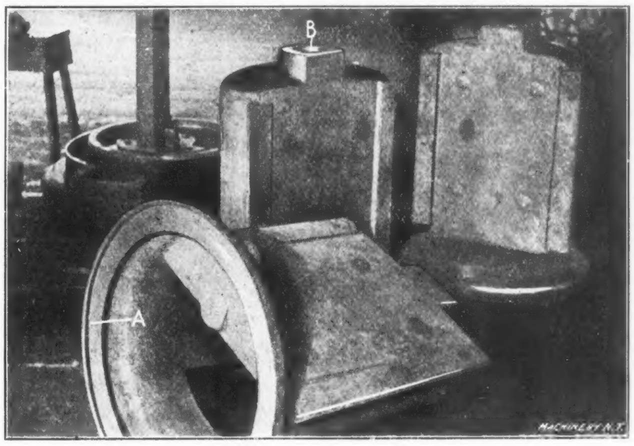

Fig. 1. Partly Machined Grinder Column Castings

correct, as it is possible to make it. The casting itself is placed on what is practically a mandrel, consisting of part *A* (Fig. 2), which passes through the bored center hole of the column, and a flange *B*, turned to fit the counterbore in the base of the column. The whole fixture is mounted on two V's and a base, and is so arranged as to be easily indexed and locked in the desired position. The casting is located on the mandrel in the correct position relative to the index holes in the flange, by means of the plug *D*, which enters the reamed elevating screw hole, previously mentioned. The first position of the casting is shown in Fig. 5, where it is ready to have the flat sides of the V's planed. After this operation the jig is indexed, as in Fig. 6, by using the pin *A*; the other side of one V is then planed, after which the jig is indexed to the opposite position and the other V finished.

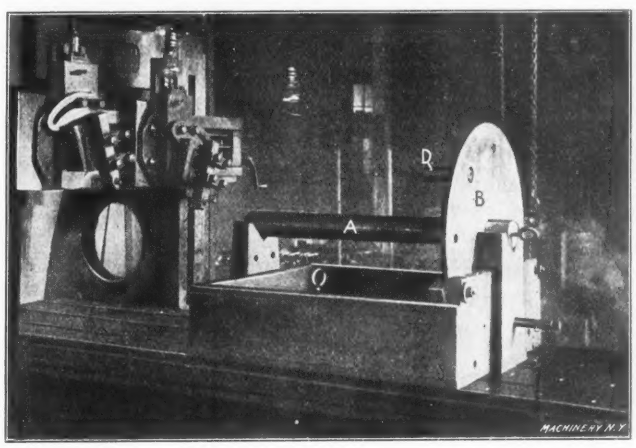

Fig. 2. Fixture used for Planing V's on Column

There are many advantages in a fixture of this kind, not the least of which is the ease with which the different planing positions are obtained, and the proper relation of the V's to the center of the column.

The knees fitting the columns are planed in gangs, using

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the jacks shown at *A*, Fig. 7. The first position of the knee is shown at *B*. After the dovetail ways are finished, they are used to locate the casting on the special angle-plate *A*, Fig. 8, and the pads *B* and *C* are finished.

* * *

OLD TAPER TURNING ATTACHMENT

A. J. Leatherman, 21 College St., Dayton, Ohio, has sent us a clipping from the *Scientific American*, November 29, 1851, illustrating and describing an engine lathe, built by J. D. White, Hartford, Conn., having a taper attachment. A patent was granted to Mr. White for the invention May 21, 1850. The attachment consisted of a guide bar mounted on the lathe bed top in front. This guide bar was adjustable to vary the angle of taper, and had a rack cut on the front surface. Just how it controlled the action of the cross-slide is not clearly shown in the illustration and description, but apparently the cross-slide was shifted with the bar, which, of course, would throw it out of square with the spindle and make it useless for squaring up when the lathe was set for taper turning. It would be interesting to learn if one of these lathes is still in use.

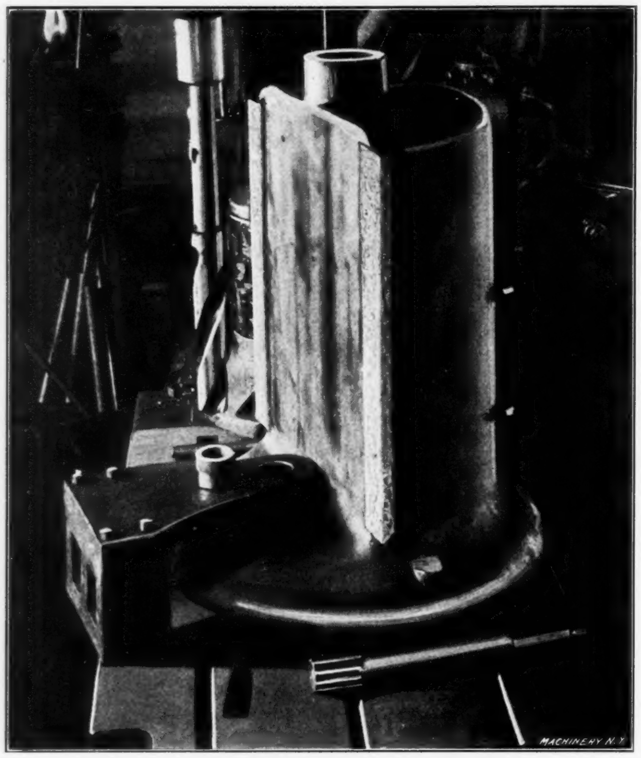

Fig. 3. First Drilling Operation on Column

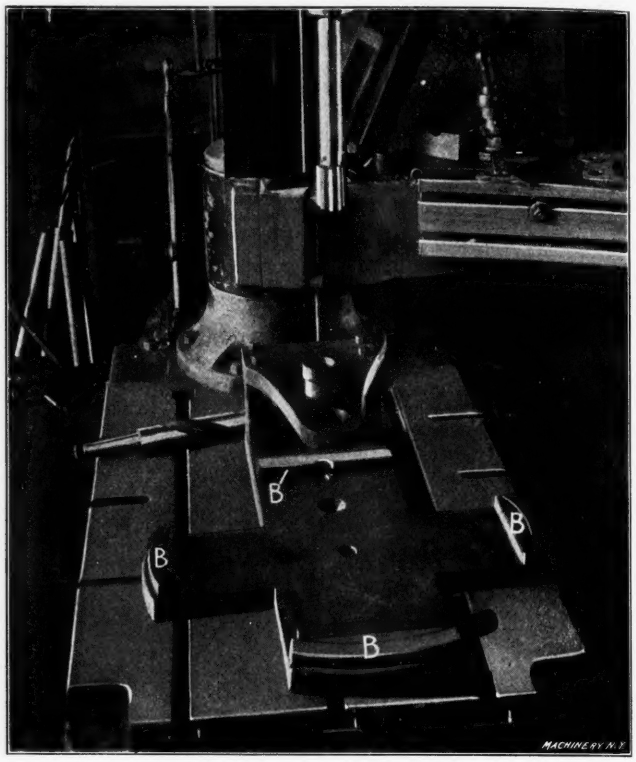

Fig. 4. Jig used for Drilling Column

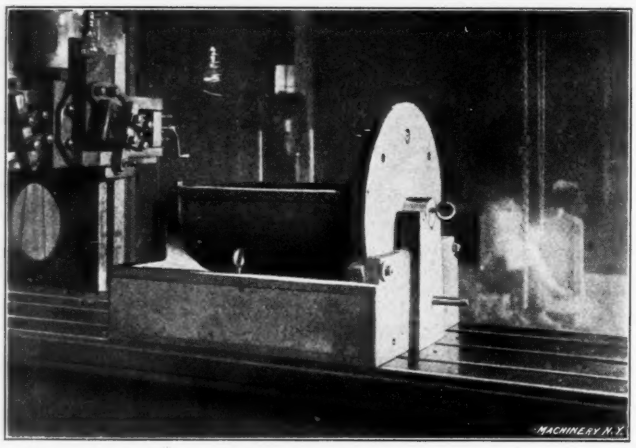

Fig. 5. First Planing Position of Column

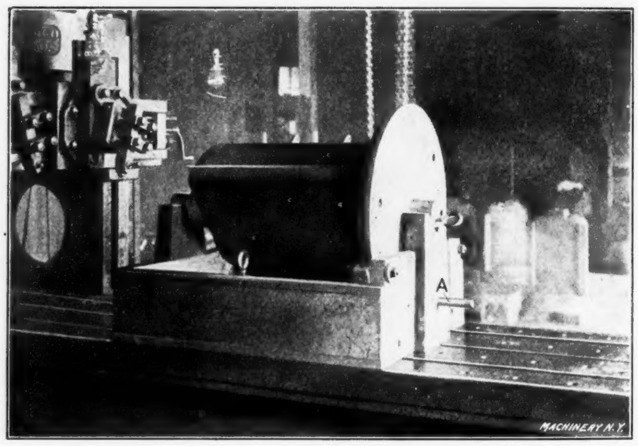

Fig. 6. Second Planing Position

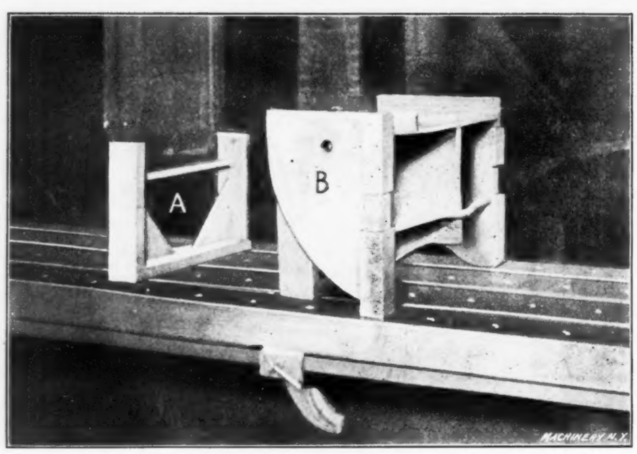

Fig. 7. First Position of Knees on Planer

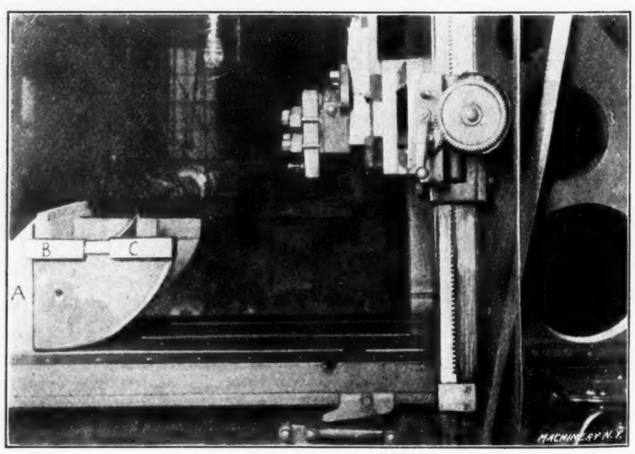

Fig. 8. Second Position of Knees

ESTABLISHING A COMMERCIAL STANDARD FOR PIPE FITTINGS*

By F. W. BARROWS†

There is no doubt that the early attempts to produce salable fittings, confined as they must have been to the filling of orders for a few of the smaller sizes, and to be used for what would now be considered low pressures only, were less hampered by competition, and the manufacturer easily produced goods which not only satisfied the customer, but also yielded a good profit. Prices were higher, and he was not obliged to count expenses so carefully. Later, competition for orders, to be obtained only at lower prices, reduced these profits; and to save himself, the manufacturer must cut down the cost. Because of the small production resulting from reduced sales, the manufacturer did not feel able to invest more capital in improved facilities, thus reducing labor cost, so a quicker and more effective method was readily found in

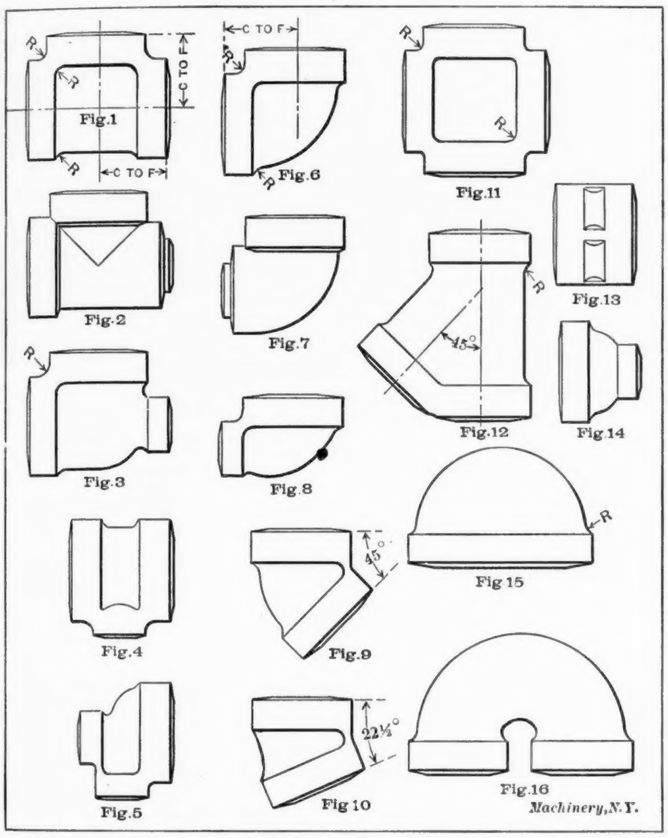

Fig. 1. 1-inch Tee. A Straight Fitting. Fig. 2. 1 x 1/2 x 1-inch Tee. Old Style Reducing Tee, Reducing on Run only. Fig. 3. 1 x 1/2 x 1-inch Tee. New Style Reducing Tee, Reducing on Run only. Fig. 4. 1 x 1/2-inch Tee. A Reducing Fitting, Reducing on Branch only. Fig. 5. 1 x 1/2 x 1/2-inch Tee. New Style Reducing Tee, Reducing on both Run and Branch. Fig. 6. 1-inch Ell. A Straight Fitting; sometimes called a Quarter-bend. Fig. 7. 1 x 1/2-inch Ell. Old Style Reducing Ell. Fig. 8. 1 x 1/2-inch Ell. New Style Reducing Ell. Fig. 9. 1-inch, 45-degree Ell. A Straight Fitting; sometimes called an Eighth-bend. Fig. 10. 1-inch, 22 1/2 degree Ell. A Straight Fitting; sometimes called a Sixteenth-bend. Fig. 11. 1-inch Cross. A Straight Fitting. Fig. 12. 1-inch, 45 degree Wye. A Straight Fitting. Fig. 13. 1-inch Coupling. A Straight Fitting. Fig. 14. 1 x 1/2-inch Coupling. A Reducing Fitting; commonly called a Reducer. Fig. 15. 1-inch Return Bend. A Straight Fitting; called a Close Return Bend. Fig. 16. 1-inch Return Bend. A Straight Fitting; called an Open Return Bend.

the reduction of weight; thus saving the profit by the saving in raw material.

This change in weight was the more willingly made, because it gave an opportunity to improve the pattern and core-box; heretofore, they had been all that could be desired, but now they were discovered to be entirely inadequate. The old outfit consisted of a single pattern and a half box, and the increasing demand for the goods made more patterns necessary; perhaps enough loose patterns were made to fill the flask, then the loose patterns were gated together and a complete core-box was made; the gated pattern and the solid core marking the first step towards reducing the labor cost.

These gated patterns, if for fittings made up of straight pipes, like tees, Figs. 1 to 5, crosses, Fig. 11, laterals, Fig. 12, or couplings, Figs. 13 and 14, were usually made of wood; if for elbows, Figs. 6 to 10, or return bends, Figs. 15 and 16, they were made of brass. The core-box, first made of wood, was quickly worn out, and was replaced by one of cast iron, cut by the machinist or toolmaker from the solid stock. The metal pattern-maker's work, at this time, was applicable only to soft metals, white metal and then brass. Later on the boxes as well as the patterns were cast from wood patterns, first in brass, when it was found that the brass boxes did not retain their roundness, the ductile metal being quickly hammered out of shape by the core-maker, and then in iron, which was a great improvement; later when the master patterns for these boxes were successfully made of plaster, it was thought no further improvement could be desired. Here the pattern improvements rested for some time and the efforts to reduce cost were concentrated upon perfecting the machines for tapping, and on increasing the output.

Automatic machines had long been used for the tapping, and they were constantly being improved. When a greater output was found necessary, additional machines were made, in which were embodied the changes found desirable. The first machine designed to tap all sizes was necessarily made heavy enough for the biggest fitting, with two or three changes of speed to accommodate the various sizes. This was further complicated by the changes made to suit the different pitches of thread, and when the need of more machines became apparent, one of the first improvements suggested was to increase the output by restricting the machine to fewer sizes, thus making its speed constant. It was still found necessary to provide for change of pitch; first, because of the constantly increasing number of reducing fittings (some idea of the variety of sizes may be had from the statement that at least one firm was prepared to furnish any combination of sizes possible, from four-inch down to quarter-inch, in either tees, crosses or 90-degree elbows) for all of which the new machines must be adapted; and later to suit the different standards, the Briggs, the English, the fine Casing threads used in oil and gas wells, and more rarely, fine threads for brass tubing; some small fittings were even tapped to fit standard bolt threads.

This change of the machine to suit different pitches, was very much simplified by making the lead-screw a continuation of the tapping spindle, and removable. Then when a change was called for, a lead-screw and nut, of the desired pitch, could be substituted for the regular Briggs' standard screw. As the machine reversed itself at a fixed point, no change of speed was necessary to accommodate the change of pitch. The improved machines soon caught up with the foundry. With the old machines, the foundry had easily kept ahead of the tapping-room, and thus escaped all complaints based on delay in getting out orders. Now the tapping-room proceeded to roll up its sleeves and show the foundry how to rush out the goods. To increase the foundry output, further improvements in pattern outfit were then found necessary, and how this was accomplished may be seen in what follows.

A one-inch ell was made from a gate of eight brass patterns (see Fig. 17), the molder putting out from 120 to 130 flasks per day; but even with this production, greater than ever before, the firm was unable to keep up with the orders, and it was suggested that this pattern be put on a "squeezer"; this was the only form of molding machine then in common use, and immediately the question came up as to what should be done about flasks. Let it be explained that the firm used the same kind of machines in the brass foundry, and had many of the patterns—made of brass for brass goods—mounted on stripping plates. The flasks used in the brass foundry were of iron, and were interchangeable as regards dowels; but the brass foundry ran three heats each day and one man or job required not more than twenty flasks.

The firm had already tried, without success, to use snap flasks on these molding machines (the writer does not know why it failed), and it seemed for a time, as though the use of stripping plates in the iron foundry depended on the cost of the flasks. The one-inch ell would require not less than 125 flasks, and we were hopeful of getting 150 molds a day. As the iron foundry took but one heat a day, it would therefore be necessary to provide 150 flasks, if our expectations were to be realized. Again, all the brass foundry patterns were fitted to one of two standard sizes of flasks; as a consequence, the molder could easily be changed from one job

* See MACHINERY, November, 1909: Pipe Fittings, Theory vs. Practice in Their Manufacture.

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to another, without any change of bottom boards or flasks. This arrangement was entirely practicable for the brass foundry, with its comparatively small run of sizes in the work produced, but would not be economical for the iron foundry, with its much greater variety of work and sizes, where the practice had been to furnish many more sizes of (snap) flasks—in fact, almost as many sizes as there were patterns. While the work might be so arranged that the molder could continue to use the same bottom boards—*depth* of flask, or a small variation only, of its size, making this possible—he was almost sure to get a new flask with the new job, and the question of being able to store so many flasks and quickly

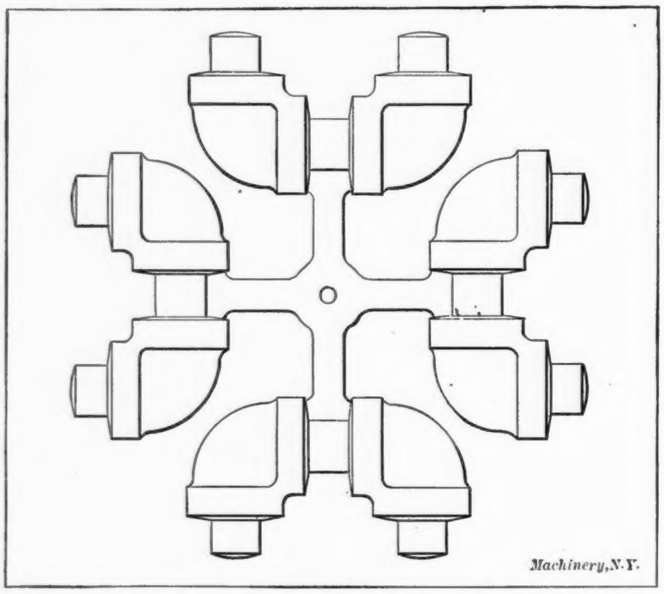


Fig. 17. Method of Gating Eight Brass Patterns

change from one size to another, threatened the success of their use. Neither was the greater cost of so many flasks to be overlooked.

Stripping plates would make cheaper help available, a fact that had already been demonstrated in the brass foundry, and as we fondly hoped, would also increase production. Both of these features would decrease cost, and therefore seemed very attractive to the firm; so it was decided to make the one-inch ell outfit and try it out with a snap flask. Taking into consideration the unskilled help we proposed to utilize, it was thought best to increase the present size of this flask and spread the patterns a little further apart, which would tend to prevent break-downs in the mold, and lessen the liability of wash by their pouring. Then it was suggested that a little more sand around the outside of the mold would make the use of bands or slips unnecessary, and the flask was still further enlarged.

The molder, like most all tradesmen, was quite conservative, and freely predicted the failure of the new pattern; but he proved to be a false prophet, for while the production went down—the result of increasing the flask size—the cost went down so much faster, that the first few days showed a saving of more than thirty per cent in molding cost, with an increasing output that promised to still further increase this saving. But in one way the molder's prophecy was verified; we had failed to increase production; in fact we had decreased it some twenty per cent, and a second set of patterns was ordered at once, as the firm could no longer afford to run the gated pattern, and this reduction of output put it still further behind its order.

The conservative molder, seeking to justify his predictions, criticised the new mold because of its, to him, unnecessary size, pronouncing it a "great big nothing," and called attention to the fact that its large size had not prevented some "run-outs." While these run-outs might well have been due to lack of skill—the new man was a laborer taken from the floor—it was thought best to use bands in the future.

Elated with the continued success of the new pattern, the molder was now in danger of becoming an extreme radical on the subject of stripping plates. He made many suggestions: the flask was too large, it took too much sand to fill it; the core-prints were too long, and the patterns could safely be placed more closely together. So a new layout, Fig. 18, was made, doubling the number of pieces, in a slightly larger flask, and shortening the core-prints. This shortening of the prints resulted finally in a reduction of core cost. Another laborer was taken from the floor gang, and given the first pattern, which had now been running some weeks; the first man who was now quite skillful, was given the new set. His first day's output beat that of the bench molder with the gated pattern, by a quarter, and reduced the cost to about one-half of what the bench molder had received.

The immediate effect of all this was a rush of work in the pattern shop, and complaints from all the rest of the factory. The stripping plates could not be gotten out fast enough; the patterns, at first made all of brass, wore out too fast, and should be made of harder metal. For this excessive wear the roughly-made molding machine was greatly responsible, the guides being very loosely fitted and thus causing rapid wear where the patterns passed through the plate when in use. Soon there was a space all around the patterns, so wide that a fin of sand would be formed on each half mold made; then when the molds were closed, these fins would be crushed together, and as the surplus sand could go nowhere else, it would be forced into the mold itself, making a very rough parting line on the castings; or perhaps the loosened sand would be washed away by the molten iron and lodge in the casting, under the core or in the top of the mold, either of these results being likely to cause its rejection by the inspector, and thus increase the percentage of bad castings far above the limit fixed by the firm. The core-prints of most patterns were too long; many of them did not match the core-box; the flask made for the first one-inch ell was too deep, and could safely be reduced, giving the molder still less sand to shovel. This question of flask size and depth, was, after some time, fixed by first allowing the necessary depth of sand for the nowel side, and then making its size as large

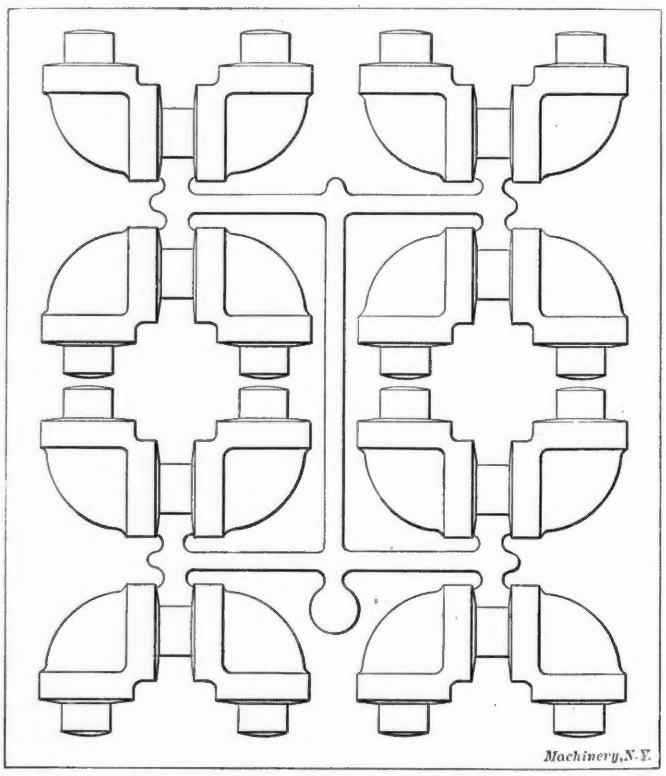


Fig. 18. Method of Gating Sixteen Patterns

as this depth of sand—and the size of the molding machine—would allow, without dropping out.

To these foundry complaints were added those from the tapping-room: such a fitting had too much stock; another wouldn't tap, *i. e.*, the hole was too large; that one was too small to clear the tap and consequently, the tap left a shoulder at the end of its run; this one couldn't be tapped through, *i. e.*, the taps would strike together if the machine allowed them to run through the thread bosses; and still another had too short a threadway.

All of these faults, it was expected, would be corrected in designing and making the new patterns; and as though the foundry complaints, supplemented by those from the tapping-room, were not enough, the office added a sort of appendix by announcing that this making over of the patterns would give an excellent opportunity to grade the fittings as to weight and size. What they really had in mind was the price list, and while they did not propose to allow any additions to present weights, they were hopeful of increasing the margin on some fittings by cutting down their weight—grading, they termed it—but sad to say, this grading, like the recent tariff revision, failed to produce any noticeable change in cost.

The first visible effects of these changes were in the design,

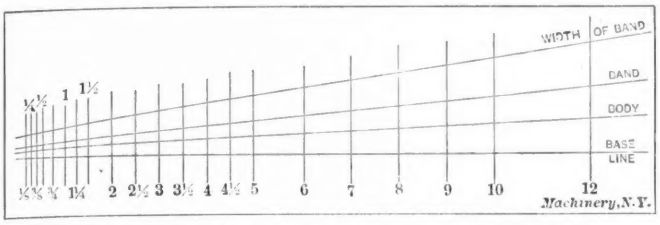


Fig. 19. First Diagram Prepared for the Design of a Graded Set of Pipe Fittings

and were most conspicuous in reducing fittings. In this designing the so-called fitting scale or diagram was used. After many talk-fests and much weighing and comparison of samples from different makers, it was decided that a set of experimental fittings, comprising tees and ells, from half-inch to twelve-inch, inclusive, should be gotten out, tested in all known ways, and criticised by all departments interested in their production. Alterations were to be made if considered advisable, and when everyone—meaning, finally, the manufacturer—was satisfied, the fittings were to be considered as standard in all respects.

To establish a temporary standard for the experimental castings, two sizes of fittings, one-inch and eight-inch, were made up, and having been corrected until their general appearance and weight were pronounced satisfactory, a diagram was drawn as shown in Fig. 19, by laying off on a base line, points through which were drawn perpendiculars marking each size of pipe. These points were spaced to correspond with variations in pipe diameter.

Having fixed, as above, on the one-inch and eight-inch sizes,

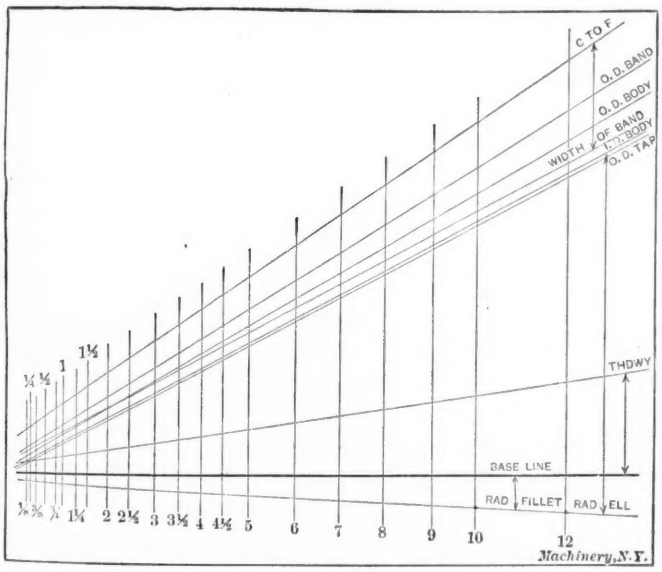


Fig. 20. Second Diagram, used for Pipe Fitting Dimensions

it was proposed to set off from the base line the dimensions of these two sizes, each on its own perpendicular; then lines were to be drawn connecting similar dimensions of the two sizes, and these lines, by crossing all perpendiculars, would fix dimensions for all sizes.

Some preliminary figuring of the thickness necessary for strength, in the different sizes of fittings, was done by using the formula $pd = 2tS$, in which

$$t = \frac{pr}{S - p},$$

p = pressure, 100 pounds per square inch,

r = outside radius of pipe = inside radius of fitting,

t = required thickness,

S = safe tensile strength of material, fixed by applying the formula $S = \frac{p(r+t)}{t}$ to the one-inch size already perfected. This gave $S = 487$, and to make even figures, the value of S was taken as 500. By the formula $t = \frac{pr}{S-p}$, the necessary thickness of the eight-inch size was found to be 0.862 inch, that of the six-inch, 0.662 inch, and of the three-inch size, 0.35 inch.

As these results were very unsatisfactory, all attempts to obtain or fix the thickness by formula were abandoned. But as all formulas for strength of pipes and cylinders fix the thickness by the diameter, other conditions being equal, the perpendiculars marking the different sizes of pipe were spaced by the normal pipe diameter, making the one-inch perpendicular the starting point.

The space between 1 and 1¼ inch was made one-quarter inch, as was also that between 1¼ and 1½; spaces for sizes from 1½ to 5 inches were made one-half inch; and from 5 inches up, one inch; all laid off in succession towards the right. To the left the smaller sizes were spaced, 1 inch down

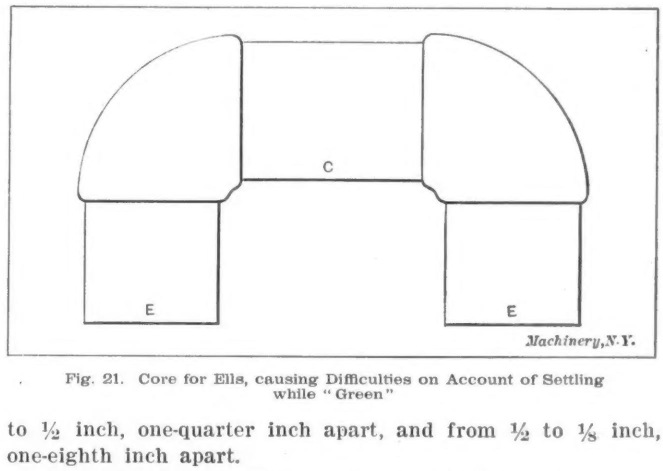


Fig. 21. Core for Ells, causing Difficulties on Account of Settling while "Green"

to ½ inch, one-quarter inch apart, and from ½ to ⅛ inch, one-eighth inch apart.

This first diagram, Fig. 19, showed thickness at end, or "band"; thickness of body, "body"; and "width of band"; three dimensions only, all to be measured on the perpendicular for desired size of fitting, and from the base line. It was the intention of the designer to establish all other dimensions—not already fixed by usage—by the tap size. The troubles of the designer had just commenced, however, as it was soon found necessary to take into account the actual outside diameter of the pipe, at the end and after it was threaded; and then to allow some regular clearance for the tap, this clearance to increase with the pipe size. The length, which it was intended to fix by adding to the outside diameter of the tap, the regular length of thread plus three threads, to clear the "run" of the machines, was not uniform. Therefore, the first scale was discarded and a second scale, Fig. 20, was made. The base line was drawn and perpendiculars for 1 and 8-inch sizes were erected, seven inches apart, as in the first scale. On these the radius of the outside of the two pipes at the end, after threading, was laid off, and a line "O. D. tap" drawn through these points. Then perpendiculars for all sizes were erected, their positions being fixed by so placing them that the space between the base line and line "O. D. tap" equalled the outside radius of each pipe. These dimensions were Briggs' standard.

From this line, "O. D. tap," a second line, "I. D. body," was established, giving one-sixteenth clearance for radius of an 8-inch tap, and one-thirty-second for a 1-inch size. Then the thickness, fixed by the two corrected fittings, was established for all sizes by the line "O. D. body." Another line, "O. D. band," fixed this dimension, and another, "C to F" graded the length. (See Figs. 1 and 6.) "Rad. fillet" was arbitrarily fixed and applies to all dimensions marked R in the illustration of the fittings. The line marked "Rad. ell"—radius of center line of ell being understood—was drawn through points, dis-

tant from "I. D. body," a distance equal to the "I. D. body" plus the radius of the fillet, and is, therefore, the same line as that marked "Rad fillet." "Width band" explains itself and is fixed by the space between "C to F" and this line; like all other dimensions, this one can thus be taken from the base line. "THDWY," meaning length of thread, was added sometime later. A complete set of tees and ells was designed from this perfected diagram, and made up and sent to the office for inspection, each piece having its weight marked in white lead.

As a set from the old patterns, similarly marked and showing the results of competitive designing, was placed in line with the new fittings, the contrast was quite marked, and the designer of the new fittings was highly complimented upon their appearance. But when the weights were noted—the 6-inch ell, for example, was some five pounds heavier than the old fitting—all further compliments were confined strictly to the general appearance.

It was at first thought that corrections in weight—ordered at once—might be made by cutting out the excess of metal from the inside, in the space between threadways; and this was done successfully in some cases. For the 6-inch ell mentioned, this method would reduce the thickness some forty per cent, which was not to be thought of, and some other way out had to be found. The price, at the time, made it impossible to produce a set of uniformly proportioned fittings which would all sell at a profit, and much time and money was expended in the efforts to produce graded fittings. Patterns have been changed and lists corrected, until much more uniform profits are now realized, but there still remains, with some manufacturers, the tendency to reduce cost—meaning weight—that a better price may be given to secure an otherwise desirable order.

When fittings were made from a single pattern, or even when a gate of patterns was used, such changes involved a comparatively small outlay, which would be increased many fold by any change in the present costly machine patterns, and the multiple core-boxes now in quite common use; so it is quite probable that the order, if it involved a change in the pattern, would now be refused.

Other reasons for continuing the present standard in use might be given; for instance: Many special fittings were made from the regular pattern by the use of a specially constructed core-box, which added nothing to the molding cost; or they were made from a special pattern fitted, when possible, to the regular box, thus saving in cost of cores, and avoiding delay in filling orders. As any change in these special fittings could be made only by the consent of the customer, who might not object to the change in the fitting, but would always object, strenuously, to any increase of cost, it is obvious that any change of the standard fitting was the more to be avoided.

Many lines of piping are in use for high pressure (200 pounds or less) which are made up with standard weight wrought iron pipe. It is practically impossible to increase the length of thread on this pipe and still conform to the standard taper, because of its limited thickness; and the fitting manufacturers take advantage of this in producing so-called heavy fittings, which can be made to fit standard core-boxes, and be tapped with standard taps.

Because of the clearance necessary for "run of machine," in tapping, any additional length of the threadway could only be obtained by adding more length to the pattern, and as core-prints had already been reduced to the shortest possible length, a new box would also be necessary, and fewer patterns, or a larger flask must be used; more time would be taken in tapping, the standard tap—if taper—would not tap through without making the fittings larger than gage, and new taps would have to be made. Other reasons for adhering to the established standard, will suggest themselves to the practical reader, who without doubt, will admit that fittings are *strong* enough, and that changes have to do with their appearance rather than with their strength.

For some time the changes made to correct weights, or as it became the custom to say, "to grade them by the list price," were noted on the diagram; but as there seemed to be no end of such changes, and also, when molding machines came into use, as more draft was found necessary on the ends of all patterns, which made it imperative to change many boxes, because the increased length of thread could not be "tapped through" without making the fittings over-size when gaged, the scale was abandoned in favor of a list for the standard fittings; but the principle was still useful when it was desired to produce fittings adapted to some new need.

The diagram in Fig. 20 was entirely successful in producing a complete set of longturns, or water fittings, as they are sometimes called, no list of prices having been previously established for these goods.

Orders for reducing fittings, Figs. 3, 4, 5, 8, and 14, which sell at better prices, weight for weight, than straight fittings, were eagerly sought after by those makers who were fortunate in possessing machinery adapted to tapping such fittings without making separate runs for each size involved; and because it was impracticable to carry separate patterns and boxes for each of the many combinations, it was the custom to place bushings in the core-boxes, to reduce some more common size to the unusual size ordered. A disposition to accommodate the customer brought more and more orders for these goods, until the bushings used, ever increasing in number, became quite an important item in pattern outfit, and it was deemed advisable to make them interchangeable.

The first move in this direction was, necessarily, to so fix the size of all boxes that while all fittings would tap a full thread and none would have too much stock—all taps for tapping machines are arranged to ream and tap at one operation—each size must be exact, or the bushings wouldn't fit. These sizes were fixed, the smaller ones by reamers, for the iron boxes, and all were made to suit plug gages.

Then, because it had been sometimes found necessary, in making unusually great reductions, to use more than one bushing, placing them one inside of the other, the length of thread, formerly made a fixed number of threads, had to be arranged so that the use of bushings did not produce unsightly shoulders in the casting or form recesses in the core-box which must be filled up before any cores could be made. The new lengths were fixed by laying down the core sizes, in parallel lines, across which other lines were drawn for outside and inside ends of the bushings. An allowance of three degrees was made at the outside end for draft, and a line drawn for the inside end which would give the nearest average of original lengths of thread. As this involved but slight changes in length no new taps were required; and because the lengths now varied with each size of pipe and not by pitch of thread only, the change gave more uniform results when the "C to F" dimensions were to be fixed.

The cost of cores had made it necessary to reduce the length of the prints to a minimum, fixed by actual needs; and they must also be round—the reamers corrected this—to avoid the removal of excessive stock, a cause, in small sizes, of the breaking of many taps; they must also fit the pattern prints; if too large, a "crush" would result, or in extreme cases, the cope would not close down, producing "plated" molds. On the other hand, if they were too small, the core would "float," and the hole in the casting would be out of center, and this would cause "flat" threads; then, because the taps—usually fitted somewhat loosely in tapping machine spindles, to prevent breakage—tried to follow the hole, "crooked" fittings, as those tapped out of line were called, would be produced.

It is impossible to avoid slight variations in size of cores, caused by wear of the box, or by changes in core after making and in process of drying. In such as are made solid, the closing of the box affects the size; and because these solid cores are dried standing on end of prints, the weight, which limits the size that can be successfully made solid, causes the core to settle down, while it is still "green," and enlarges the ends which support it. This weight causes ell cores, Fig. 21, to settle down at the unsupported center, *C*; and while the weight enlarges the ends, *EE*, the sagging of the center spreads the ends apart; this is another cause of "crushing."

Many attempts to so arrange patterns and boxes that these faults might be overcome resulted finally in the production of a second set of gages, to be used in sizing prints, and made with a gradually increasing difference, as the sizes grew larger, between diameter of core-box gage and that of the print gage.

In some cases an allowance was made, in ell cores, for the spreading, by making the distance between the centers of the pattern prints slightly larger than that between the centers of the core prints, or rather, of the core-box.

In the tapping-room many castings were cracked in tapping, a fault not always discovered by the inspector, and therefore the cause of many complaints from customers. It is very easy to crack a pipe fitting on its parting line, as in nearly all fittings the partings of core-box and pattern are both in the same plane, making lines more or less pronounced—the whole length of the casting. These lines weaken the casting just the same as scoring or nicking with a file would weaken it; therefore the dowels of both box and flask should be nicely fitted, and kept so. Some patterns were strengthened at the points marked *R* to prevent this cracking, and care was taken in fitting all false jaws in which the castings were held by the chuck while being tapped.

Twenty-five years ago seventy pounds steam pressure was considered high enough for all ordinary purposes and fittings carrying steam at one hundred pounds were few; now one hundred is about the minimum, and even this is endured, in many cases, only because the boiler inspector could not be persuaded to further raise the limit; and the manufacturer, needing more power and too poor to install an entirely new power plant, was obliged to help out this pressure by increasing the speed of the old engine, designed for seventy pounds and seventy revolutions, up to one hundred revolutions. This was all that could be coaxed from the old Corliss gear, and even at this high speed and increased pressure, steam often followed the whole length of stroke, repairs became more frequently necessary and weak spots developed in all steam lines. This brings us back to the necessity for *better* fittings, not heavier, perhaps, for a great deal *can* be done in the matter of threading; both pipe and fittings could be much improved in this respect.

The die for threading is quite commonly made too thin to cut the Briggs' standard length of thread on the pipe, and in the effort to keep the end of the pipe *small* enough, is so made that it leaves an abrupt shoulder at the end of the thread. It should be thicker, that both the taper and length of thread may conform to the standard. If the fitting is tapped slightly over-size, this shoulder comes up against the fitting before the tapered end fills the hole. If the thread holds, this shoulder may be forced hard against the end of the fitting; hard enough to make a tight joint at seventy pounds, but which *might* leak after the pressure had been raised to one hundred.

Small fittings, sizes up to ¾ and 1 inch, and in some shops, to 1¼ incn, are tapped straight, manufacturers claiming that they will make up just as tight as though tapped taper. The real reason for tapping them straight is found in the cost of taps.

Large taps are made by inserting cutters—parallel bars of steel with one side threaded—in grooves milled parallel with the surface of the tapered tap body. These cutters are held in place by a threaded ring which engages the thread on the cutters and also a thread cut upon the rear end of the tap body, enlarged for this purpose to match the cutters. The cutters may therefore be advanced to compensate for the length lost in the grinding, by unscrewing this ring, sliding them along their grooves and then replacing the ring.

As the cutters are made very cheaply, this construction saves much expense; but it is obviously impracticable to make the smaller sizes in this way, and they have to be made solid. If then they were tapered, grinding the end—which has to ream out the rough hole in casting and therefore requires frequent sharpening—would soon spoil the size, and they are consequently made straight, another effect of which the price-list is the cause.

Enough has been said to convince the practical reader that the market-price is the principal thing to be considered in designing standard fittings; and also that this designing will be confined to changes in their appearance rather than in their weight, unless the manufacturer "sits in the game."

* * *

An industrial or trade education is an education in the art of making things. A technical or engineering education is an education in the art of getting things made.

DESIGNING ECCENTRICALLY LOADED BOLT AND RIVET GROUPS*

By HARRY GWINNER†

When a beam or bracket is eccentrically loaded as shown in Fig. 1, tangential shearing stresses are often produced in the rivets or bolts, which are far in excess of the direct shearing stresses due to the vertical load. The direct shearing stress on each rivet is equal to the given load divided by the number of bolts or rivets. In addition to this there is a tangential shearing stress due to the eccentricity of the loading. The resultant of these two shearing stresses must not exceed the shearing or bearing value of the bolts or rivets. A practical example will best illustrate this matter.

Example:—A cantilever or bracket supports a load of 5,000 pounds 18 inches from the center line of the support *H*, as shown in Fig. 1. It is required that a suitable group of rivets, giving ample safety, be designed.

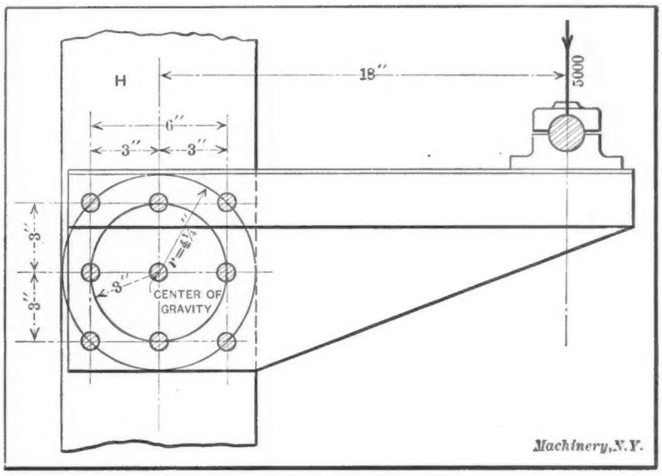


Fig. 1. Eccentrically Loaded Rivet Group

In the accompanying Data Sheet Supplement will be found four tables which will greatly facilitate the solution of problems of this kind. These tables are for rivets ¾ inch in diameter, stressed at 10,000 pounds per square inch, giving a safe stress for the rivet area of 4,400 pounds. The first step in designing the rivet group is to assume a certain arrangement for the rivets. In the present case, assume that we decide upon three vertical lines of rivets three inches apart, as shown in Fig. 1. This will make the extreme distance between the outside rivets six inches. The vertical spacing of the rivets should be three inches, the tables in the accompanying Data Sheet Supplement being calculated for this spacing.

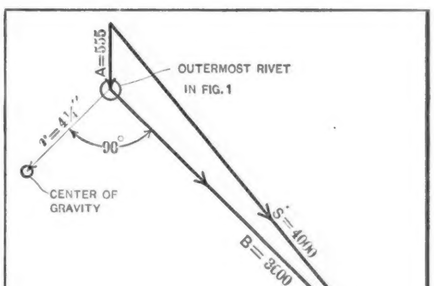


Fig. 2. Finding the Total Resultant Shearing Stress on the Rivets

In Sheet III of the accompanying Supplement, a table is given for finding the number of rivets required when arranged in three lines. We locate in this table first the main section headed "18 inches" which is the lever arm of the load. In this section we follow the column under 6 inches, which is the distance between the outside rivet holes, until we come to the figure 5.6, which gives the load in thousands of pounds, or, in this case, represents a load of 5,600 pounds. This is the nearest figure in the table to the given load. Now we follow the horizontal line from 5.6 to the extreme left, and find the number of rivets required for carrying the load, which in this case equals 9.

* With Data Sheet Supplement.
† Dean of Mechanical Engineering, Maryland Agricultural College, College Park, Md.

As a check, on this work, we may carry out the following calculations:

$$\text{Direct shear} = A = \frac{5{,}000}{9} = 555 \text{ pounds.}$$

$$\text{Tangential shear} = B = \frac{W\,L}{P} = \frac{90{,}000}{25} = 3{,}600 \text{ pounds.*}$$

In the formulas above

A = vertical component of the total shearing stress on the rivet,

B = component of shearing stress caused by the eccentric loading,

W = total load in pounds,

L = distance from the center of rivet group to load,

P = polar section modulus.

The polar section modulus P is found from the accompanying table in the section headed "Three Rows of Rivets," opposite the number of rivets which, in this case, is 9, and in the column headed "6," which is the distance between the centers of the extreme rivets in a horizontal direction. This gives us 25 for the polar section modulus in this case.

The resultant of A and B is found graphically as shown in Fig. 2, and is about 4,000 pounds. This is well within the limits of the safe shearing stress of the rivet and the arrangement is, hence, a safe one. In testing the arrangement for strength, attention should also be given to the bearing value of the rivet or bolt on the connecting plates. If the resultant S should exceed the bearing value, the grouping should be re-arranged so as to make the joint safe both for shearing and bearing. The approximate formula

$$N = \frac{\dfrac{W\,L}{a} + W}{V}$$

gives results practically correct for a wide range of cases. In this formula

N = total number of rivets,

V = safe stress in one rivet,

a = average distance from center of gravity to rivets, and

W and L denote the same quantities as in the formulas previously given.

It may be of interest to some to know how the polar section modulus or the values of P given in the table above were calculated. Considering the group just designed we will find its section modulus.

$$\text{Polar section modulus} = \frac{\text{polar moment of inertia}}{r}, \; r \text{ being the}$$

distance from the center of gravity of the group to the center of the most remote rivet. The polar moment of inertia, designated I_p, is equal to the sum of the products of the area of each rivet multiplied by the square of the distance of each rivet from the center of gravity. In Fig. 1,

$$r = \sqrt{3^2 + 3^2} = 4.25, \text{ approx.}$$

Each rivet is assumed to be of unit* area. In the group under consideration we have four areas at the distance of 4¼ inches from the center of gravity, four at a distance of 3 inches, and one at 0 inch. We then have

$$\begin{aligned} 4 \times 1 \times 4.25^2 &= 72 \\ 4 \times 1 \times 3^2 &= 36 \\ 1 \times 1 \times 0 &= 0 \\ \hline I_p &= 108 \end{aligned}$$

Fr^2

Hence, the polar section of modulus equals

$$\frac{I_p}{r} = \frac{108}{4.25} = 25,$$

which is approximately the same as the value already found from the table.

* * *

The industrial growth and development of Sweden during the last twenty years is indicated by some figures recently published by the Swedish government. The development has, in fact, been so remarkable that it reminds one rather of the boom of a new territory rather than the normal development of an old country. The value of the products of Swedish manufacturing industries in 1887 was only Kr. 191,000,000 ($51,000,000), while in 1907 this value had risen to Kr. 1,496,000,000 ($405,000,000), or an eight-fold increase in twenty years. This great development in the industries has, of course, brought with it a development in other lines as well. The assessed valuation of properties in towns and cities has increased from Kr. 1,040,000,000 ($280,000,000) to Kr. 2,800,000,000 ($775,000,000), and in the country districts the assessment of property other than agricultural has increased from Kr. 272,000,000 ($73,000,000) to Kr. 1,050,000,000 ($283,000,000). This development in the manufacturing industries is largely due to the fact that with the exception of the southern portion of the country, Sweden is not as well suited for agricultural pursuits as some other countries, while it is exceptionally well fitted for a large industrial development owing to the fact that water power is cheap and abundant and that the people in general are mechanically inclined.

* * *

In the January, 1907, issue of MACHINERY the Plauen bridge in Germany was referred to as having the longest masonry bridge span in the world. The span of this bridge is 295.2 feet long. It is now surpassed by the Grafton bridge near Auckland, New Zealand, which is 910 feet in total length and 40 feet wide, and which has a middle arch of 320 feet span, the roadway of this span being 147 feet above the valley.

VALUES OF POLAR SECTION MODULUS FOR UNIT AREA OF RIVETS AND FOR ONE, TWO, THREE AND FOUR VERTICAL ROWS OF RIVETS

One Row of Rivets		Two Rows of Rivets						Three Rows of Rivets					Four Rows of Rivets				
No. of Rivets	Value of Pol. Sec. Mod.	No. of Rivets	Horizontal Distance between Rivets					No. of Rivets	Horizontal Distance between Outside Rivet Rows				No. of Rivets	Horizontal Distance between Outside Rivet Rows			
			3	6	9	12	15		6	8	10	12		9	12	15	18
1	0	2	3	6	9	12	15	3	6	8	10	12	4	10	13	16	20
2	3	4	8	13	19	24	30	6	14	18	21	25	8	22	28	35	41
3	6	6	14	21	29	37	46	9	25	30	35	40	12	38	46	55	64
4	10	8	22	30	39	50	61	12	38	43	49	56	16	56	66	77	89
5	15	10	32	40	50	64	77	15	53	59	66	74	20	77	89	102	116
6	21	12	44	52	63	77	93	18	72	77	86	94	24	102	116	130	146
7	28	14	58	66	77	93	110	21	93	99	107	116	28	131	145	160	178
8	36	16	75	82	94	110	128	24	117	123	131	141	32	163	178	194	213
9	45	18	93	100	113	129	148	27	144	150	159	168	36	199	215	232	252
10	55	20	113	120	132	149	170	30	174	180	189	199	40	240	256	273	294
11	66	22	135	142	154	172	192	33	207	214	222	233	44	284	300	318	339
12	78	24	159	166	178	196	216	36	243	250	258	268	48	332	348	365	390

* Note that the stress thus found is the stress in each ¾-inch rivet and not the stress per square inch. While the formula used is that commonly employed for finding the stress per square inch, the result in this case is due to the fact that the polar section modulus P is not the section modulus for a group of rivets of ¾-inch diameter, but for a group where each rivet is of unit area. The method of obtaining the polar section is explained later in this article.—EDITOR.

* When this is done the stress B as previously found, becomes the stress per each rivet and not the stress per square inch. See previous note.—EDITOR.

DERIHON "FRICTION MILL" FOR TESTING THE DURABILITY OF METALS

In the April number of MACHINERY (page 647, engineering edition) was described a portable apparatus for measuring the hardness of metals, designed by the firm of Usines G. Derihon at Loncin-lez-Liége, Belgium. This was used particularly for testing the hardness of metals used in automobile construction, the makers being engaged in the business of furnishing drop forgings for this work. The apparatus herewith illustrated and described was devised by the same firm for testing

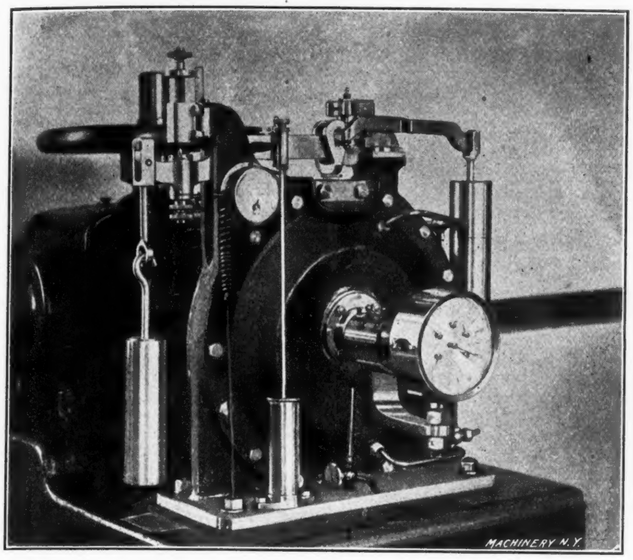


Fig. 1. An Apparatus for Measuring the Susceptibility of Metals to Wear

the durability of metals subject to wear. This has also found its greatest use in the hands of the makers in investigating the suitability of various materials for use in automobile construction, for such applications as gears, bearing metals, etc., where durability is a prime requirement.

With this apparatus the metal to be tested is subjected directly to wear under working conditions—that is to say, the wearing is effected by contact with a moving metal surface well lubricated; the only departure from working conditions lies in using a greatly increased pressure to hasten the action. Suitable means are provided for measuring the wear by an accurate micrometer screw. The machine may be used for measuring the friction developed as well, but it should be noted that its specific purpose is that of measuring the rate at which a test piece of any material is abraded or worn away under the conditions imposed.

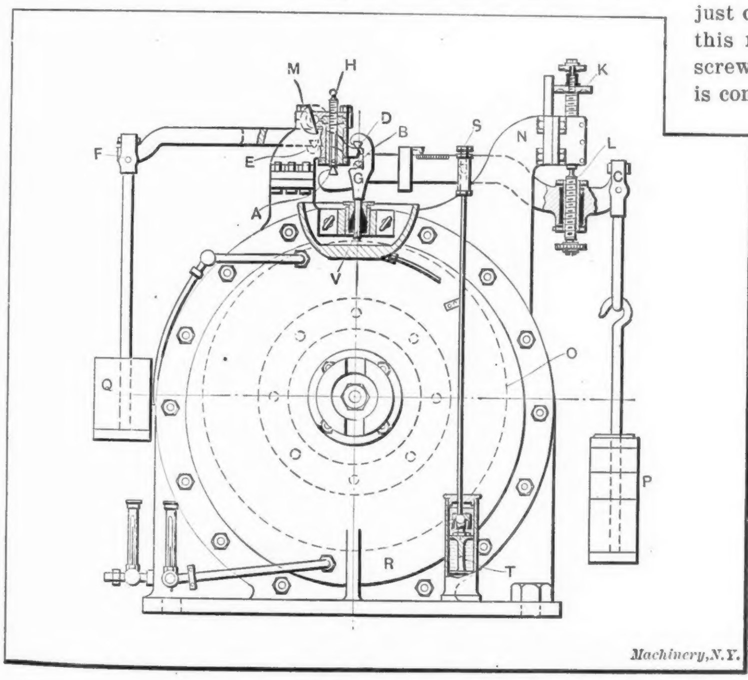
The apparatus itself is shown in Fig. 1, while Figs. 2 and 3 show the construction. It comprises a casing *R*, in which is mounted a disk *O* of extra hard steel rotated from a motor or other prime mover at a constant rate of speed. A holder *V*, containing the sample to be tested, is pressed down on the periphery of the revolving disk by an accurate and adjustable set of weights, *P* and *Q*. The amount that has been worn off from the sample by the revolving disk is tested from time to time by micrometer screw *K*.

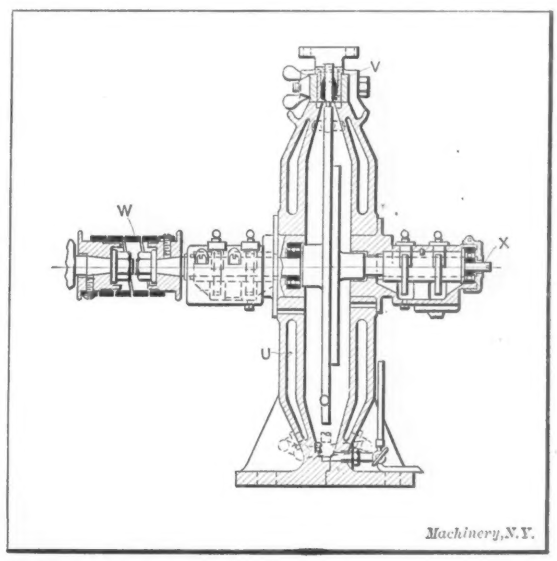
Casing *R* is filled about one-third full of oil to give the condition of lubrication desired. This casing is water-jacketed, space for this being provided at *U* as shown. By regulating the water supply, the temperature of the casing is kept constant so that the factor of temperature does not have to be considered in comparing various tests. Disk *O* is one meter in circumference, and may be revolved at from 500 to 3200 revolutions per minute, giving a surface speed varying from about 27 to 175 feet per second.

The test piece is in the form of a small cylindrical plug, set into the square shank *V* of stirrup *G*. This square shank is carefully adjusted and fitted in the stuffing box guide shown, to avoid vibration and oil leakage. Care in the latter particular has to be exercised owing to the high centrifugal force with which the oil is thrown from the revolving disk.

The pressure is applied to the sample by means of weights *P*, hung on the outer end of the lever whose knife edges are shown at *A*, *B* and *C*. The fulcrum is at *A*. This bears on an abutment having a screw adjustment by means of screw *H* and worm *M*; by using this, lever *A*, *B*, *C* may be brought to the horizontal position at the beginning of the test. The upper end of stirrup *G* carries a knife edge *D*, which receives the upward pressure of a lever pivoted at *E* and carrying weight *Q* at its outer end. The purpose of this lever and weight is simply to balance the system before weights *P* are put in place. A sliding scale on the weighing lever provides the fine adjustment necessary for effecting this equilibrium. Weight *Q*, by furnishing another point of contact for stirrup *G* at *D*, serves also to hold the latter firmly in position.

With the test piece in place in *V*, and the levers set to the horizontal position by adjustment *M*, as described, the first thing to do is to set the micrometer screw to read from zero. Disk *K* being set at zero, screw *L* is turned until the points just come into contact. No dependence is placed on feeling in this matter, as that would not be delicate enough. Instead, screw *L* is insulated from the lever in which it is seated, and is connected by wire with a battery and galvanometer through





Figs. 2 and 3. Elevation and Section of the Derihon "Friction Mill" for Testing Durability

the frame of the machine. By this means, just as the points of *L* and *K* come into the most delicate contact, that contact is registered on the galvanometer.

When the machine is started up with the micrometer dial *K* thus set at zero, the wear reduces the length of the sample plug of material in *V*, allowing weight *P* to drop. At regular intervals the amount of this drop is noted by screwing down micrometer screw *K* until the galvanometer again shows contact. Since the ratio of distance *AB* to distance *AL* is 1 to 10

and the graduations on dial K read to 0.01 millimeter, actual changes in the length of the test specimen as fine as 0.001 millimeter are read directly, and with accuracy. A dashpot T is supplied, as shown, connected with lever A, B, C, by spring connection S. This steadies the action of the lever, tempering the vibrations and making fine measurements possible. The ratio of distance AB to AC is 1 to 12, so that the pressure applied is easily found.

The apparatus is shown ready for work in Fig. 1. It is provided as shown with revolution counters, galvanometer and thermometers for indicating the temperatures of the jacket water. A motor is shown direct connected to the apparatus. This may be provided with volt and ampere meters if it is desired to make records of the power absorbed in friction. Since, however, this frictional loss is largely due to the friction between the plate and the oil bath, rather than that between the plate and the test piece, such use is not recommended.

In using this apparatus in testing the durability of metals, some investigations were made to see if there is any relation between nardness as measured by the Brinell apparatus, and durability as measured by this machine. No direct relation between the two characteristics was discovered. The accompanying table gives particulars of a series of experiments along this line. In these experiments the test piece was subjected to a pressure of 48 kilogrammes per square centimeter (682 pounds per square inch), with the friction disk turning at 3200 revolutions per minute or 175 feet per second, for a period of ten million revolutions.

An examination of the table proves that the presence of carbon has an unexpectedly small effect on the resistance to wear as compared with manganese and silicon. This is in accordance with the experience in railroad work, in which rails high in manganese and silicon have been found to wear less rapidly than when these elements are lacking. It would seem that the carbon has practically no effect at all, since half hard steel having a high percentage of manganese and silicon wears much less than hard steel having a small percentage of these two elements. Compare, for instance, samples 1 and 2 in the table, the latter of which was worn out nearly twice as rapidly as the former. Not until this second sample had been hardened, as shown in test No. 7, could it be compared with respect to the wearing of sample No. 1.

It is evident and, in fact, proved by experience as well as by these experiments, that heat treatment has an effect on the resistance to wear. Mild steel which in the natural state wears 0.325 would only wear 0.025 if casehardened and tempered. Similar improvement occurs in nickel chromium steel.

Similar tests have been made on bronze and other bearing metals. Bronzes containing lead and antimony are of the kind which resist wear best, in spite of their weak cohesion. One of tne test bars was so soft that an 8 millimeter ball under a weight of 12 kilogrammes made an impression on the metal. This same test bar, however, gave the smallest coefficient of wear. Hard bronze, on the other hand, such as phosphor-bronze, wears more rapidly. Hard bronzes have broken down and abraded as soon as the pressure reaches one kilogramme per square millimeter (1422 pounds per square inch) in the machine. On the contrary, soft and anti-friction bronzes have never acted in this way, whatever the pressure used.

The designers of this apparatus are now studying the effects of elements other than lead and antimony for bearing metal purposes, and expect to be able to publish valuable results in the near future. The information here given was sent us by the American representative of Usines G. Derihon, Mr. H. A. Elliott, 7502 Carnegie Ave., Cleveland, Ohio.

COMPARISONS OF VARIOUS STEELS FOR DURABILITY AND HARDNESS

No. of Sample	Analysis							Breaking Strength	Elastic Limit	Elongation per 100 m m.	Contraction per cent	Hardness Number (Brinell)	Rate of Wear (Derihon)
	Carbon	Manganese	Silicon	Sulphur	Phosphorus	Chromium	Nickel						
1	0.20	1.30	0.50	0.02	0.05	....	....	92,500	54,100	32	64	156	85
2	0.43	0.80	0.30	0.02	0.06	....	....	116,600	71,200	18	50	255	151
3	0.06	0.50	0.02	0.03	0.01	....	....	56,900	55,600	40	70	99	325
4	0.36	1.70	0.16	....	....	....	....	109,500	79,700	20	....	187	57
5	0.38	1.35	0.08	....	....	....	....	126,600	101,000	14	....	187	80
6	0.34	1.20	0.06	....	....	....	....	130,800	105,300	13	....	196	200
7 (No. 2, tempered)	0.43	0.80	0.30	0.02	0.06	....	....	185,000	175,000	....	20	340	89
8 (No. 3, casehardened and tempered)	0.06	0.50	0.02	0.03	0.01	....	....	....	....	....	....	228	25
9 (casehardened and tempered)	0.08	0.33	0.16	0.01	0.01	1.20	4.76	....	....	....	....	444	20
10 (air tempered)	0.28	0.48	0.22	0.01	0.02	1.43	4.55	242,000	227,000	10	30	387	28

* * *

RUSTPROOF FINISH ON IRON

The so-called "Coslettizing" process for producing a rustproof finish on iron is referred to in a recent issue of the *Brass World*. This process consists in boiling the iron or steel article to be treated in a solution of one gallon of water, four ounces of phosphoric acid and one ounce of iron filings. By this means a black coating is produced on the iron or steel which protects it from atmospheric and other corrosive influences. This formula gives good results when care is used, but when carelessly handled a certain amount of undissolved iron filings may be left on the surface of the article being treated. As far as the protection of the coating against corrosion is concerned, it is stated that a piece of steel treated by the process and immersed in salt water for nearly a year has resisted its attacks so that it is practically free from corrosion, while a similar piece untreated has become badly rusted.

* * *

The rifle barrel rollers in the Springfield Armory, Springfield, Mass., evidently are not superstitious; at least they seem to have no fear of the hoodoo "13." The billets from which the barrels are rolled are passed between a pair of rolls having eleven grooves, the grooves being shaped so as to roll the barrels large at the breech and small at the muzzle. A barrel is passed once through each groove, except the finishing groove, through which it is passed three times, thus making thirteen passes in all.

IRREGULAR SPACING OF THE CUTTING EDGES OF REAMERS*

By "A"

The question of the proper manner in which to "break up" the flutes of reamers (spacing the cutting edges irregularly), is one which has puzzled mechanics considerably. Some claim that if the flutes of half of the reamer are broken up exactly alike with the other half of the reamer, opposite cutting edges hence being exactly diametrically opposite, the object sought, *i. e.*, the elimination of chatter and the possibility of reaming a round hole, would be obtained. Others maintain that the cutting edges around the whole reamer should be irregularly spaced so that no two cutting edges are diametrically opposite.

The advantages obtained by having the two halves of the reamer identical are that the reamer can be exactly measured, and that an equal width of the land of all the cutting edges can be more easily obtained if desired, as the milling machine table on which the reamer is mounted while fluting would have to be raised or lowered only half the number of times for obtaining this result than would be the case if every tooth were irregularly spaced. The writer, however, does not believe that these advantages in any way outweigh

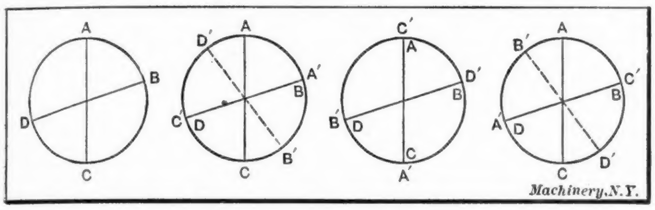


Fig 1 Fig. 2 Fig 3 Fig. 4
Four-fluted Reamer, with Cutting Edges Diametrically Opposite. Note Coincidence of Cutting Edges at Various Times during the Revolution

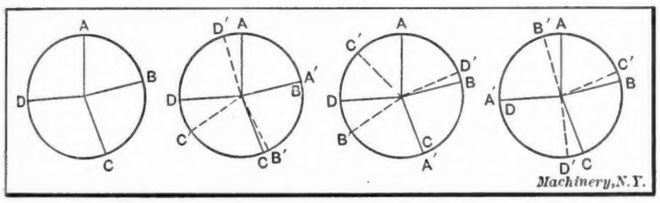


Fig. 5 Fig. 6 Fig. 7 Fig. 8
Four-fluted Reamer, All Cutting Edges Irregularly Spaced. Note that there is no Coincidence of the Cutting Edges during the Whole Revolution

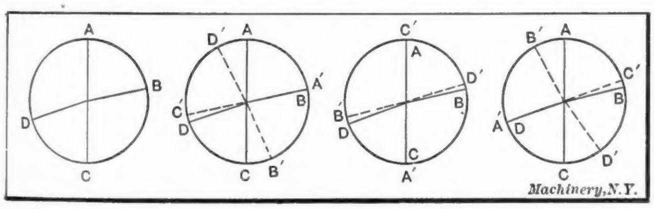


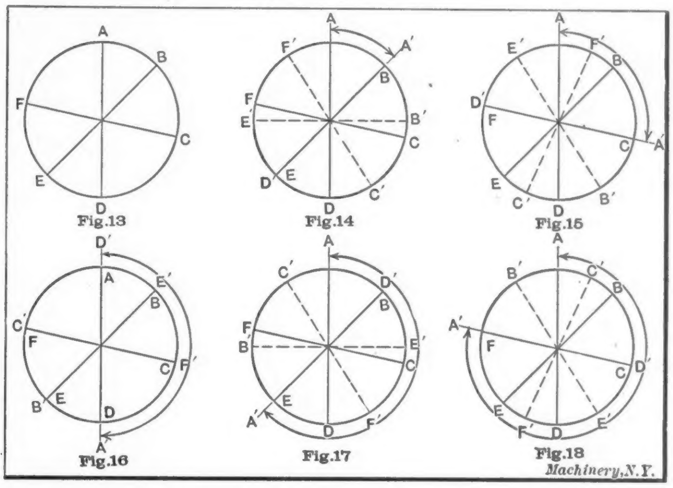
Fig. 9 Fig. 10 Fig. 11 Fig. 12
Four-fluted Reamer, with only Two of the Cutting Edges Diametrically Opposite. This gives Practically as Good Results as shown in Figs. 5 to 8

the disadvantages resulting from this method. When the flutes are not irregularly spaced all around the whole reamer, the tool is liable to chatter, and if it once starts to cut a "cornered" hole, it will continue to do so.

The accompanying illustrations will show why this happens. First, take as an example the case of a four-fluted reamer. Assume that the cutting edges are irregularly spaced as shown in an exaggerated manner in Fig. 1. When this reamer is revolved the cutting edges *A* and *C* will simultaneously occupy the positions originally occupied by *B* and *D*, as shown in Fig. 2. When it is revolved further, *B* and *D* will simultaneously occupy the positions originally occupied by *A* and *C*, and when it has been revolved half a revolution, as shown in Fig. 3, all four cutting edges will occupy the same relative positions as in Fig. 1. In Fig. 4, again, cutting edges *A* and *C* occupy the original positions of cutting edges *D* and *B*. This action is conducive to the production of a four-cornered hole.

* The following articles dealing with the construction and making of reamers have previously been published in MACHINERY: "Hand Reamers," January, 1906; "Reamers," August, September, October, November, and December, 1907.

In Figs. 5 to 8, again, are shown the relative positions occupied by the cutting edges of a reamer having four flutes irregularly spaced all around the whole circumference. It will be seen that here no two cutting edges at any one time will occupy the same position as has been occupied previously by any other two cutting edges, letting alone the fact that the positions of all four cutting edges never coincide except at the end of a full revolution. In Figs. 9 to 12 is shown a method of spacing the cutting edges where two

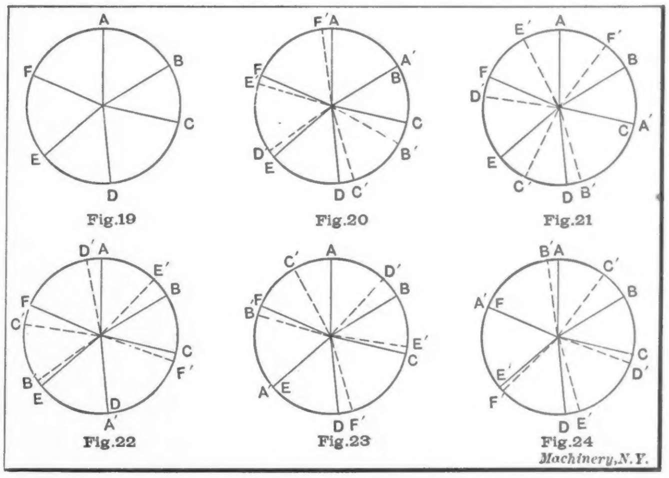


Figs. 13 to 18. Reamer with Six Flutes. Cutting Edges Diametrically Opposite

of the edges *A* and *C* are diametrically opposite, while *B* and *D* are not. This method of spacing the flutes is practically as effective as that shown in Figs. 5 to 8, and when the reamer revolves, the positions of the four cutting edges will never coincide, except when the reamer has been turned around a full revolution. If the reamer starts wrong or commences to chatter, a reamer of the type shown in Fig. 1 has no possibility of correcting itself, whereas reamers broken up in the manner shown in Figs. 5 and 9 will do so.

The illustrations, Figs. 13 to 18 and 19 to 24, show reamers with six flutes. In the first case all the cutting edges are diametrically opposite each other and in the second case all of them are irregularly spaced so that no two are diametrically opposite. The illustrations shown in connection with these, indicate how in the first case, the positions of two and two cutting edges coincide constantly, and how after half a revolution all the cutting edges coincide, whereas, in the second case, there is no coincidence of position of any two cutting edges until the reamer has been turned around a complete revolution.

The error in measuring a reamer when all the cutting



Figs 19 to 24. Reamer with Six Flutes. Cutting Edges Irregularly Spaced

edges are irregularly spaced, and when no two are diametrically opposite, is very slight. The irregular spacing should be so small that the error in measuring should not exceed 0.0003 inch. It has been the experience of a toolmaker of both mechanical and commercial experience that this is rather an advantage, as the reamer, when new, will be a small

amount oversize, providing a slight allowance for wear which is not too great even for a hand reamer. In general, there is no need of a greater irregularity in the spacing of the flutes than that the error may be limited to 0.00025 inch.

As far as concerns the difference in the width of the land of the reamer edges, which is the inevitable result of breaking up the flutes if the table or the cutter is not raised or lowered between consecutive cuts so as to make up for the difference in spacing, the writer does not consider this matter of enough importance to warrant any deviation from the best practice of spacing the cutting edges. The only reason for lands of even width would be for the sake of appearance, as the unequal width of the lands in no way interferes with the efficiency of the reamer. The commercial difficulties in making the lands of equal width, however, are rather too great to warrant unnecessary expense on account of a matter which has no mechanical importance.

* * *

MACHINE SHOP PRACTICE*

TOOL GRINDING–2

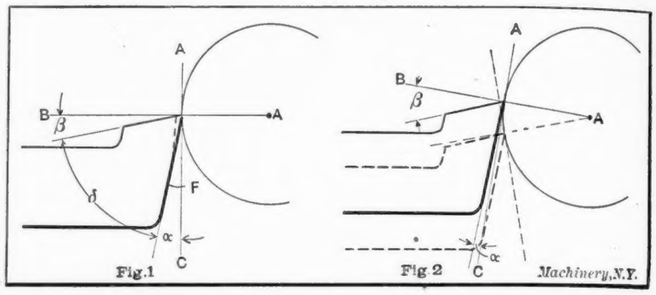
In the preceding installment of this article which appeared in the March number, the shape which should be given the cutting edge of a tool was considered in a general way and it was also explained that the slope for tools which require slope, should be back from the *working part* of the cutting edge, as this is necessary in order to give keenness to that part of the edge which does the work.

Now, in order that the cutting edge may work without interference, it must have clearance; that is, the flank F (Fig. 1) must be ground to a certain angle a so that it will not rub against the work and make the cutting edge ineffective. This clearance should be just enough to permit the tool to cut freely. A clearance angle of eight or ten degrees is about right for lathe turning tools, while three or five degrees is sufficient for planer tools.

As was explained in the Shop Operation Sheet accompanying the March number, the back slope of a tool is measured from a line A-B (Fig. 1) which is parallel to the shank, and the clearance angle, from a line A-C at right angles to line A-B. These lines do not, however, always occupy this position with relation to the tool shank when the tool is in use. As shown in Fig. 2, the base line A-B for a turning tool in use, intersects with the point of the tool and center of the work, while the line A-C remains at right angles to the first. It will be seen then, that by raising the tool, the effective clearance angle a will be diminished, whereas lowering it, as shown by the dotted lines, will have the opposite effect. The effective angles of slope and clearance of a planer tool will also change when its position with relation to the work is varied; thus, in Fig. 3 a tool is shown in a normal position; if this tool were inclined as in Fig. 4, evidently the effective clearance would be greatly increased while the slope angle would be zero, with the result that the tool instead of cutting or shearing the metal, would work with a scraping action. A planer tool is, however, always clamped in a fixed position with the shank at right angles to the table as shown in Fig. 3, whereas a lathe tool, the height of which may be varied, is not always clamped in the same position. This is one reason why a turning tool is given more clearance than one used for planing. The turning tool also requires more clearance because it has a continuous feed and cuts along a spiral path instead of along a straight path, as in the case of a planer tool which is fed at the end of the stroke.

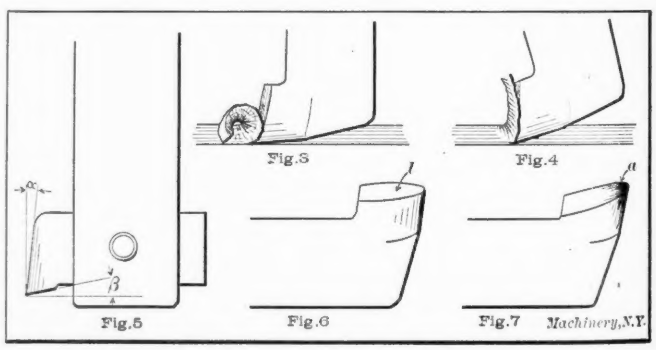
A turning tool for brass or other soft metal, particularly where considerable hand manipulation is required, could advantageously have a clearance of twelve or fourteen degrees, as it would then be easier to feed the tool into the metal; but, generally speaking, the clearance for turning or planing tools should be just enough to permit them to cut freely. Excessive clearance means that the cutting edge will be weakened by a lack of support which may result in its crumbling under the pressure of the cut.

The lip angle or the angle of keenness δ (Fig. 1) is another important consideration in connection with tool grinding, for it is upon this angle that the efficiency of the tool largely depends. By referring to the illustration it will be seen that this angle is governed by the clearance and the slope β, and as the clearance remains practically the same, it is the slope which is varied to meet different conditions. Now, the amount of slope a tool should have depends on the work for which it is intended. If, for example, a turning tool is to be used for roughing medium or soft steel, it should have a back slope of eight degrees and a side slope ranging from fourteen to twenty degrees, while a tool for cutting very hard steel should have a back slope of five degrees and a side slope of nine degrees. The reason for decreasing the slope and thus increasing the lip angle for harder metals is to give the necessary increased strength to the cutting edge to prevent it from crumbling under the pressure of the cut. The tool illustrated in Fig. 6 is much stronger than it would be if ground as shown in Fig. 7, as the former is more blunt. If a tool ground as in Fig. 6,



Figs. 1 and 2. Illustrations showing how Effective Angles of Slope and Clearance change as Tool is raised or lowered

however, were used for cutting very soft steel, there would be a greater chip pressure on the lip surface l, and consequent greater resistance to cutting, than if a keener tool had been employed; furthermore the cutting speed would have to be lower, which is of even greater importance than the chip pressure; therefore, the lip angle, as a general rule, should be as small as possible without weakening the tool so that it cannot do the required work. Experiments conducted by Mr. F. W. Taylor to determine the most efficient form for lathe roughing tools, the results of which were previously published in MACHINERY (January to August, 1907, engineering edition) showed that the nearer the lip angle approached sixty-one degrees, the



Figs. 3 and 4. Effect of Change of Position on Action of Planer Tool. Fig. 5. Slotter Tool. Figs. 6 and 7. Lathe Roughing Tools Ground for Turning Hard and Soft Steel

higher the cutting speed. This, however, does not apply to tools for turning cast iron as the latter will work more efficiently with a lip angle of about sixty-eight degrees. This is because the chip pressure when turning cast iron comes closer to the cutting edge which should, therefore, be more blunt to withstand the abrasive action and heat. Of course, the foregoing remarks concerning lip angles apply more particularly to the tools used for roughing cuts.

In order to secure a strong and well-supported cutting edge, tools used for turning very hard metal, such as chilled rolls, etc., are ground with practically no slope and with very little clearance. Brass tools, while given considerable clearance, as previously stated, are also ground flat on top or without slope; this is not done, however, to give strength to the cutting edge, but rather to prevent the tool from gouging into the work, which it is likely to do if the part being turned is at all flexible and the tool has been given slope.

Slotter tools for general work, such as the one illustrated in Fig. 5, are ground in practically the same way as a planer tool.

* With Shop Operation Sheet Supplement.

If we consider a slotter tool, which is, of course, a vertical planing tool, under working conditions, we shall see that the angle α represents the clearance and β the slope, which is given, as with lathe and planer tools, to that surface against which the chip bears while it is being severed.

Often a tool which has been ground properly in the first place, is greatly misshapen after it has been sharpened a few times. This is usually the result of attempts on the part of the workman to re-sharpen it hurriedly; for example, it is easier to secure a sharp edge on the turning tool shown in Fig. 1 by grinding the flank as indicated by the dotted line, than by grinding the entire flank. The clearance is, however, reduced and the lip angle changed.

There is great danger when grinding a tool of burning it or drawing the temper from the fine cutting edge, and, aside from the actual shape of the cutting end, this is the most important point in connection with tool grinding. If a tool is pressed hard against an emery or other abrasive wheel, even though the latter has a copious supply of water, the temper will sometimes be drawn, which will be indicated by a dark blue color at the point, as at a in Fig. 7. Burnt tools are, however, sometimes discolored so slightly that the discoloration is scarcely discernible, for naturally it is the fine cutting edge from which the temper is first drawn, and it is also this fine edge which does the work.

When grinding a flat surface, to avoid burning, the tool should be frequently withdrawn from the stone so that the cooling water (a copious supply of which should be provided) can have access to the surface being ground. For the same reason a curved surface should be constantly rolled about on the face of the wheel. A moderate pressure should also be applied, as it is far better to spend an extra minute or two in grinding, than to ruin the tool by burning it in an attempt to sharpen it quickly. Of course, what has been said about burning, applies more particularly to carbon steel, but even self-hardening steels are not improved by being overheated at the stone.

As to the kind of abrasive, the writer believes that there is nothing superior to a free-cutting grindstone for tool grinding. A little more time may be required when a grindstone is used, but the fineness and quality of the edge obtained which results in increased tool efficiency, is by far the more important consideration.

* * *

THE GROWTH OF CAST IRON

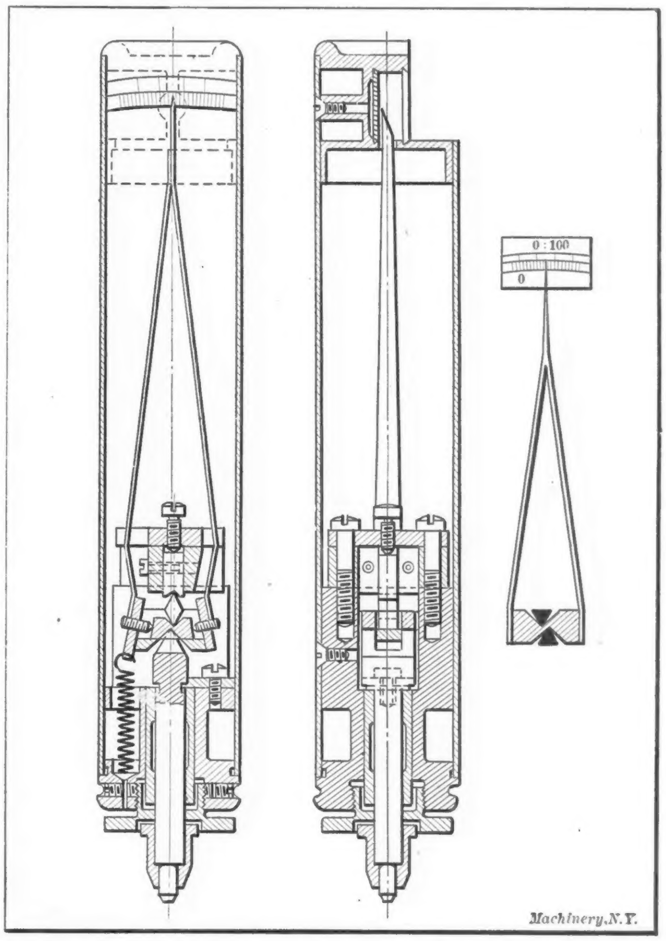
In an article entitled "The Growth of Cast Iron" in the March, 1910, issue of MACHINERY, a comparison was made of the results obtained in the experiments made by Prof. H. F. Rugan and Prof. H. C. H. Carpenter with those obtained by Mr. A. E. Outerbridge, Jr. It was stated that Mr. Outerbridge's experiments did not show an increase in weight of a sample which had increased in volume after repeated heatings, while the other experimenters' samples showed an increase in weight as well as in size. As an explanation of this condition it was stated that Mr. Outerbridge had his samples enclosed in an iron pipe sealed at the ends with clay. Our attention has been called to the fact that the other experimenters heated their samples in the same manner, using an iron muffle furnace sealed with fire clay, so that in this respect there was no material difference in the manner of heating the samples. While the specimens were thus completely protected from the direct action of the flame, the results of the experiments indicate that the gases entered the muffle. Iron heated to the temperature used, about 1470 degrees, becomes permeable to gases. Hence the manner of heating does not account for the difference of the results obtained by the different investigators.

* * *

From the preliminary reports of an industrial census recently taken in Great Britain, it appears that the value of the machine tools built in that country in 1907 was $13,575,000. Of other classes of machinery, locomotives were built valued at $22,100,000, this, however, not including the locomotives constructed by the railway companies themselves. The total value of all classes of machinery built in Great Britain was $450,000,000 in the year mentioned.

THE HIRTH MINIMETER FOR ACCURATE MEASUREMENTS

The accompanying illustrations show a measuring apparatus devised by Mr. Albert Hirth of the Fortuna Works, Cannstatt-Stuttgart, Germany, intended for a comparator to indicate differences of fractions of millimeters existing between the piece measured and a standard gage block, or between the piece measured and a sample piece of arbitrary dimensions. The general construction of the minimeter is shown in Figs. 1 and 2, and the principle of its action in Fig. 3, this principle being the introduction of a long lever arm which at the same time serves as an indicating needle, and a short arm the length of which is determined by the distance between two knife edges. The bearing points of these two knife edges may be varied in order to provide adjustment for the apparatus. One of the advantages of the device is that it eliminates the necessity for lubrication and overcomes the disadvantages of play on dead centers. As indicated in Fig. 1, a spring holds the lever against the knife edges and returns it to its normal position after measuring. The whole mechanism is



Figs. 1 to 3. Construction and Principle of Action of the Hirth Minimeter

enclosed in a tube, the upper part of which is provided with an opening which permits a graduated scale to be seen and the indications of the pointer to be read off. The scale is provided with graduations corresponding to hundredths of a millimeter (about 0.0004 inch). The measuring instrument proper can be mounted in different holders so that it can be used with equal facility for measuring flat and round pieces as well as inside diameters of holes.

In Fig. 4 the minimeter is shown arranged for measuring, or rather comparing, dimensions of flat pieces. In this case the instrument proper is mounted on a standard or upright, carrying at its upper end a clamp for holding the minimeter and at its lower end a small circular table placed on a bracket adjustable for height. When cylindrical pieces are to be compared, the instrument is mounted as shown in Fig. 5. In this case the location of the measuring instrument proper is adjusted by means of the adjusting mechanism shown on the side of the holder, so that the indicator points to zero when the sample or standard gage is placed in the holder. Then

the differences in dimensions of the various pieces are noted by inserting them in the instrument in place of the sample or gage. For measuring inside diameters the instrument is mounted as shown in Fig. 6. In this case the minimeter is held in a bracket having a two-point support provided with means for adjustment so that it can be easily applied to the required diameter.

It is evident from this brief description that the apparatus is a very convenient one for machine shop use. It permits of a comparison of different measuring instruments and gages at given intervals, without the employment of relatively costly standard measuring machines. When standard gages are at hand it indicates exactly the size that the piece of work must have in order to obtain the desired degree of accuracy. It is so simple in its application that it may be employed by the ordinary mechanic as easily as any of the ordinary measuring instruments with which he is familiar. It is evident that this instrument can be applied to many special uses not directly referred to in this description.

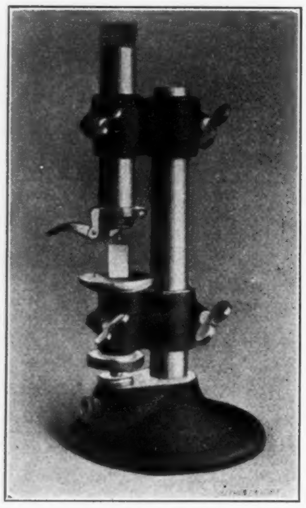


Fig. 4. The Minimeter mounted for Measuring on Flat Surfaces

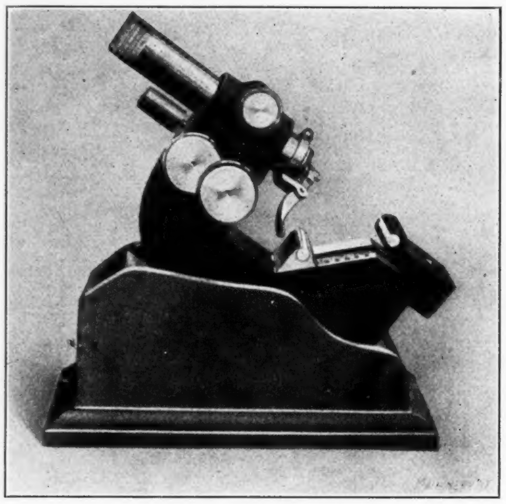


Fig. 5. Minimeter mounted for Use on Cylindrical Surfaces

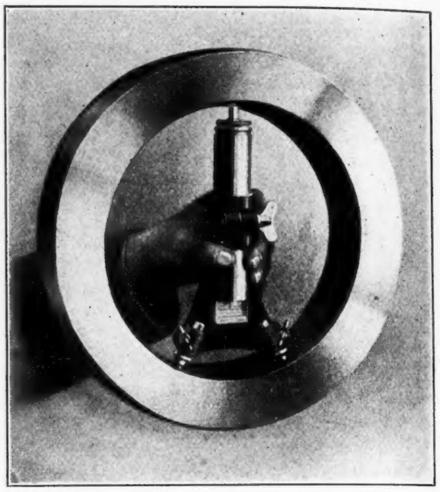


Fig. 6. The Minimeter used for Internal Measurements

* * *

MAKING FILMS IN A VACUUM

A new method of producing thin metallic films by volatilization in a vacuum was described at a recent meeting at the Academy of Science by Prof. L. Houllevigne, which may have an important commercial influence on the production of gold leaf. The metal to be deposited is first deposited on platinum wire which is then heated in a high vacuum. The film forms on a glass cylinder which is kept in constant rotation near the heated wire. In this manner thin films have been produced of gold, silver, platinum, copper, zinc, tin and cadmium.

* * *

Barney Oldfield drove a 210-horsepower Bens racer one mile in 27.33 seconds at Daytona Beach, Fla., March 16. He broke the former world's mile record of 28.23 seconds made by Fred Marriot with a Stanley steam car in January, 1906, on the same course. The speed attained by Oldfield averaged 131.72 miles per hour.

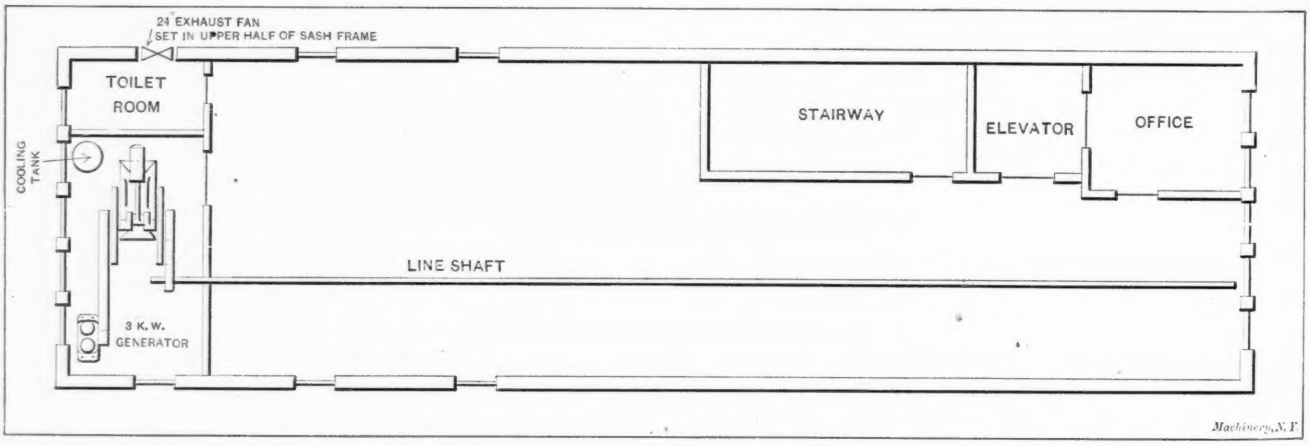
INSTALLATION OF STATIONARY GAS ENGINES FOR FACTORY USE

By H. J. BACHMANN*

The use of stationary gas engines for industrial purposes in New York state, has been made difficult where the provisions of the factory law are not complied with. It is a well-known fact that the burnt gases which escape from any explosion engine will soon contaminate the air to such an extent as to render it unfit for breathing purposes. The law requires that al work-rooms be provided with sufficient means of ventilation, and it is therefore necessary to make provision for exhausting the foul gases and admitting a constant supply of fresh air.

In the accompanying engraving a typical floor plan of a small loft building such as is used for a large variety of manufacturing purposes, is shown. It is a mistake to place a motor, especially a gas engine, in an out-of-the-way dark corner of a room and expect satisfactory results. In such a location, the motor is neglected, often becomes over-heated, and repairs are made with difficulty. When the engine is located as shown, it takes up a large amount of otherwise available floor space and light, but the benefits derived from such a location more than compensate for the additional expense involved. In the first place, the power plant is in a large, light room, entirely separate from the manufactory, so that it is easy to keep it clean and well ventilated. There is also room for a small generator, which will furnish current for electric light and such small portable electric tools as are used in the shop. This will also do away with another source of vitiated air; namely, the burning of gas jets at each machine, to say nothing of the additional safety and comfort to the operator. If it is desired, this current may also be used for ignition purposes in place of batteries or hot tubes.

The opposite side of the engine is belted direct to the line-shaft, as shown, from which a drive is taken for the 24-inch



Plan of Small Factory driven by Gas Engine, showing Ideal Arrangement

* Address: 1234 Theriot Ave., New York City.

exhaust fan which is set in the upper part of the sash frame in the toilet. All the partitions shown, run up to the ceiling except the one between the engine room and toilet. With this arrangement the fan will keep the air of both these rooms in as good condition as outdoors without perceptible draft.

If a forced circulation of air is also desired in the factory, a register may be placed near the ceiling in the partition between the engine and work-room, which may be opened or closed to secure the desired result. Furthermore, provision may be made for the supply of fresh air through the windows by opening each sash slightly at the top and bottom. To prevent a draft from this source, the windows may be fitted with any good make of window ventilator.

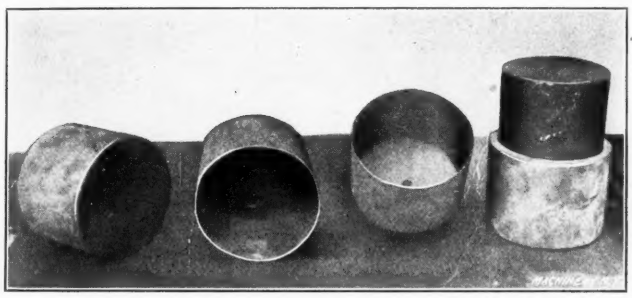
A manufacturing plant arranged as outlined will come up to the strictest requirements of the health and factory laws and may be run in the most economical manner as regards expense for power consumption. Incidentally, the working conditions will be favorable toward securing the steady services of high-grade, intelligent workmen.

* * *

THIN CASTINGS

By WILLIAM PAINTER*

The gray iron castings which are shown in the accompanying illustration do not exceed 1/16 inch in thickness at any point, and they are made commercially in quantities to take the place of sheet metal cups. These castings have practically no draft and they must be without blow holes as they are required to be water-tight. They are made in five different sizes, but only two sizes are shown in the illustration. The four larger ones of those illustrated are 8 inches in diameter



Cup-shaped Castings which do not exceed 1/16-inch in Thickness

and 6 inches deep, and the smaller one is 7 inches in diameter and 5 inches deep. The weight of the larger size is 3 pounds 4 ounces, while that of the smaller one is 2 pounds 8 ounces. The smallest size which is cast is even less than 1/16 inch in thickness and its weight is only 1 pound 4 ounces. This smallest cup has a diameter of only 6 inches and a depth of 4 inches, while the two larger sizes have a diameter of 9 and 12 inches and a depth of 9 and 10 inches, respectively. The weight of these castings must not vary more than 4 ounces.

The work is done under the direction of our foreman iron molder, Mr. Fred Hockenberry, and the process is as follows: First, the pattern which is of metal, is turned to the weight required, the patternmaker allowing from 2 to 8 ounces over the weight of the casting for which the pattern is intended. They are made perfectly straight on the outside, with 1/32-inch draft inside, so a molder will see at once the necessity of rapping the pattern when removing it from the sand.

There are three ways of molding these floats. A two-part flask cut in the middle and having a cope and drag may be used, or a three-part flask having a cope, cheek, and drag, or a two-part snap flask, where flask is removed; and a slip or outside box is forced over the mold; this latter method is not safe, as in forcing the box over the mold, a crush is likely to follow.

The sand used for this job was one-half No. 0 Albany and one-half No. 0 Dresden thoroughly tempered. The greatest care must be taken in wetting and thoroughly mixing the sand, so there will not be any wet or dry parts to come in contact with the pattern, as they will cause blowing or scabbing of the casting.

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When molding a float in a two-part flask the molder places the pattern on a plain board; the drag half of the flask, which should be 2 inches deeper than the pattern, is then placed over the latter, and filled about half full of sand sifted from a No. 6 riddle. The sand is then peened around the pattern evenly, care being taken not to leave hard and soft spots that might cause a blow or swell in the casting. After the molder has the first course of sand peened evenly, he makes the second riddling. Care should be taken to see that the pattern is covered, and that there are no soft spots between the two riddlings. The flask is then filled with sand, and rammed properly, and the loose sand is struck off on the bottom board. This board must be set level on the sand edges of the flask. The board is next removed and the sand is vented inside and out of the pattern, so that all gases such as steam and air may escape, as in castings as thin as these any gas that cannot escape will cause a hole in the side wall of the casting. After the venting is done, the board is placed on the flask which is then rolled over. We now have the pattern in the drag half of the flask. The parting is made, care being taken that the sand be firm around the top of the pattern; parting sand is put on the mold, and the cope half of the flask is placed on. The ears should be tight on the pins so that the cope cannot shift. Sprues are placed in opposite corners for pouring, and also in the remaining corners for risers. Enough sand is then riddled to cover the top of the pattern, the sprues are thoroughly tucked around, and the cope is then filled with sand and well peened to get the sand firmly back of the sprues so as to prevent a "run out." The sand should not be rammed too hard over the top of the pattern, as it will cause blow holes and cold shots. The sand is next vented, care being taken not to strike the pattern; the pattern is then rapped through the cope. It should not be rapped much, however, as there is only an allowance of 4 ounces to go on.

After the sprue-pins are removed, the cope is lifted. The gates can best be cut before the pattern is drawn, as then there is no danger of loose sand dropping down the side wall. The gating is one of the important points in casting these floats. A runner should be cut to the right and left of the sprues about 1 inch wide and ½ inch deep.

Leaders to the casting 1½ inch wide and 1/16 inch thick at the point of entering the mold, tapering back to a size of ¾ inch wide by ¼ inch deep where they join the runners, will allow the iron to flow into the mold easily, saving the cutting of the green sand core. The gate should be well thumbed down, so that no loose sand can wash into the mold, as a small particle of sand flowing with the iron and dropping down the side, will leave a hole in the casting. A straight gate is cut into the riser to relieve the strain as the mold has to be forced very hard.

The pattern is drawn with two screws, and great care has to be taken not to break the sand, so as to allow any loose particles to fall in, as it is impossible to remove them. After the pattern is removed, the cope is closed onto the drag, the mold is placed on the floor, and enough weights are placed on the flask to insure the cope not rising when the iron is poured.

The best hot iron is used, and the mold is poured two up; after pouring, the mold is allowed to stand until it is thoroughly cold. As the castings are very thin they snould not be exposed to the air while hot, as they are likely to crack by cooling too quickly.

The iron which is used is high in silicon and low in sulphur. Some manganese is added for strength and phosphorus for fluidity. An analysis of the iron used is as follows: Silicon, 2.75; sulphur, 0.005; manganese, 0.20; phosphorus, 0.60; coke, 0.60 to 0.75 in sulphur.

* * *

The dangers of atmospneric electricity in aerial navigation are attracting considerable attention. While an ordinary balloon without metal parts is not exposed to any danger as long as it floats in the air, the modern dirigibles are provided with much framework made of conducting metals. Even a balloon, however, may be charged with electricity and a spark produced when contact with the ground is made, thus setting fire to the gas.

LETTERS ON PRACTICAL SUBJECTS

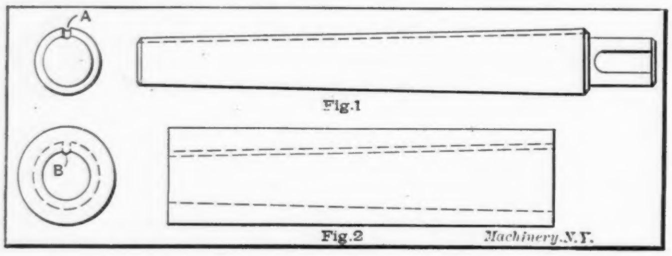
We pay only for articles published exclusively in MACHINERY

LAPS AND THEIR USE

I have read carefully the interesting article on "Laps and Points on Lapping" by Mr. F. P. Crosby in the February number, and no doubt he has successfully used the method described. However, my experience has been that copper is not a metal to be quickly and accurately worked, and I am sure that Mr. Crosby's method would not be practical in a shop where nearly every hole is finished by lapping—by all classes of workmen. I should be afraid that the split lap, as shown in Fig. 3 of the article referred to, would expand and revolve on the arbor, possibly causing particles of emery to become loose and lodge in the work, especially if it were of brass or aluminum. This style of lap and method of holding might be suitable for very small tool work, but even then it would be expensive.

In consideration of the above article, and in view of the fact that accurate lapping is a very difficult operation for many machinists, it would seem fitting at this time to again consider it in a light possibly new to some. Lapping is not, however, as difficult as it would seem, providing the proper methods and tools are used in the process.

I consider the material used for holding the abrasive one of the most important factors when the work is soft; and it is very important that this material should be softer than the work, which would make it easier to charge. In shops where nearly every hole is finished by lapping, lead has been adopted as the best known metal to use. It is inexpensive and can be



Figs. 1 and 2. Lap Arbor and Lead Lap with Driving Key

remolded by apprentices; besides it charges very quickly, which is a much desired and important feature.

The lap arbor illustrated in Fig. 1 is used for holding the lead laps, which may be molded in as many sizes as desired. The molding arbor should be an exact duplicate of the working arbor. A small groove A is milled the entire length of the molding arbor, producing a driving key B, Fig. 2, which fits the working arbor. This driving key is very necessary, as it is almost impossible to prevent considerable lap friction between the work and the lap. Without the driving

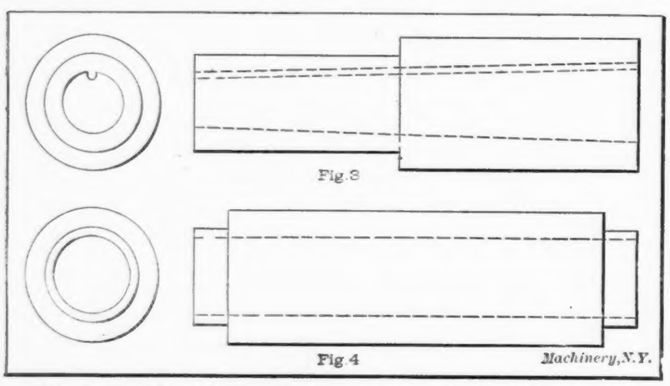


Fig. 3. Lead Lap with Two Diameters. Fig. 4. Method of Preventing Bell-mouthed Holes

key, the lap would surely revolve on the arbor and become tight in the work.

It is very convenient to have laps with two or more diameters, as shown in Fig. 3, which enables the operator to readily find a size without a waste of metal for each job. It may be necessary, of course, to slightly reduce one of the diameters to obtain the desired size. The usual custom is, when a lap is a little too small, to flatten it between two parallel plates in an arbor press, which forces the metal outward on the open sides.

For outside lapping or "ringing" a cast-iron adjustable lap is used, similar to the one shown in Fig. 5. Any piece of cast iron will do, but it is much better to have special castings of several sizes for this purpose, with holes in each end as shown. The slots and holes serve to hold the loose particles of the abrasive.

Fig. 4 shows a method of preventing a "bell-mouthed" hole (large at the ends). A shell about 3/16 inch long is left

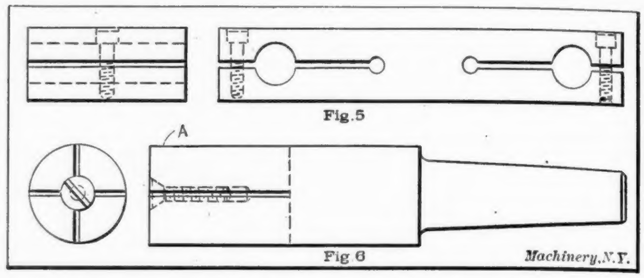


Fig. 5. Adjustable Cast-iron Lap. Fig. 6. Form of Lap for Blind Holes

on each end of the work, which is cut or ground off after the lapping is finished. This will remove the bell-mouthed part, which is otherwise practically unavoidable. The causes of a bell-mouthed hole are as follows:

1. Too much loose emery and oil at the mouth of the hole, which assists in cutting faster.

2. Lapping too long in one position, causing the cutting medium inside the hole to become dull, so that the abrasive which is outside, being sharp, cuts faster.

3. Lap arbor under-size, not straight, and too long. When possible, the contact portion of a lap should be shorter than the work, which will greatly assist in preventing a taper hole.

Fig. 6 shows the style of lap to use in a hole which bottoms, or does not extend through the piece to be lapped. It is slotted and tapped for an expansion screw, which makes adjustment very easy. The slots hold the loose particles of abrasive. This style of lap is usually made of cast iron, and has a taper shank which is fitted to the drill press or lathe spindle. With it a hole which bottoms can be lapped straight, as the point of contact on the lap extends back from the end about 1/4 inch to a point A; beyond this point it is slightly tapering.

If the methods given in the foregoing are not in accordance with the best practice, I shall be very glad to read in the columns of MACHINERY of any which have been actually and successfully used in high-class and very accurate machine and tool construction, where quality and quantity have been the guiding powers.

S. C. S.

PLAINER LETTERS AND FIGURES IN DRAFTING-ROOM AND SHOP

Everybody will agree that letters and figures too plain and distinct would be difficult to obtain. Many will also agree that certain small details properly attended to would contribute much to a quicker and clearer understanding of written characters of all kinds. Is it not a curious truth that characters representing sounds—letters—are in the case of the twenty-six used in our language, so diverse in form that each may easily be distinguished from any and all the others—though few mistakes would occur if this were slightly otherwise—while in the case of the nine digits where one character gives absolutely no clew to the identity of any other when used in groups, and where the identity of each character is of relatively great importance, we use forms that not only may be but often are mistaken one for the other?

Even on the printed page, that in all cases is viewed from the bottom only, the use of sixes and nines which are the same inverted, is to be condemned; and in shop drawings and tool marking it is utterly indefensible. The forms of numerals used by most persons in writing are far superior to those

in use by most draftsmen on their drawings or by the designers of typewriter type, or the designers of stamps in general. Not only should the nine be different in *form* from the six and all other figures, but eights, threes and fives should each be so distinct in form from all the others that a slight failure to print clearly or a slight wearing or dirtying of a print, or carbon copy, would not lead to error or that annoying uncertainty so often met with in the shop.

It is needless to say that no radical change can be undertaken. An attempt on the part of the writer to distinguish the figure seven by the use of a short horizontal line across the center of its stem soon led to its abandonment because sevens so treated were persistently read F.

A brief review of the nine digits as used by draftsmen,

Fig. 1. Suggested Changes in the Form of Figures

diesinkers, type designers and some others, leads to the following suggestions: Avoid the use of the "Roman"; it has perverted so upright a character as the figure one and made it look like other things. Two has suffered also.

The figure three is good with flat or a curved top, with a wide open low-hanging lower lip or a return curve making the lower opening more like a slightly enlarged upper opening of a curved top three, but care should be used that the fives and eights used therewith are so different as to make confusion of the characters difficult. A good combination would seem to be a flat top three—no Roman on the left end of the flat—and an open lower part (see specimen A, Fig. 1).

The five to be used with this three should be fairly well

862		551	556	561	566	571	576	581	586	591	596
863		601	606	611	616	621	626	631	636	641	646
864		651	656	661	666	671	676	682	687	692	697
865		702	707	712	717	722	727	732	737	742	747
866		752	757	762	767	772	777	782	787	792	797
867		802	807	812	817	822	827	832	837	842	847
868		852	857	862	867	872	877	882	887	892	897
869		902	907	912	917	922	927	932	937	942	947
870		952	957	962	967	972	977	982	987	992	997
871	94	002	007	012	017	022	027	032	037	042	047
872		052	057	062	067	072	077	082	086	091	096
873		101	106	111	116	121	126	131	136	141	146
874		151	156	161	166	171	176	181	186	191	196

Fig. 2. The Clear, Open Style of Figures commonly used in Mathematical Tables

closed (see specimen B). Then the eight of the usual form would not be mistaken for either three or five.

Six as usually made is not open enough. Many steel stamps of medium and small size have the figure six of such a closed form as to make reading uncertain even where there is no question of confusion with nine. An open figure six (specimen C) is certainly much clearer and less liable to misreading than one of those would-be artistic affairs (specimen D).

The figure seven has suffered slightly at the hands of the vertical writer who sometimes forgets to be even vertical, and makes his stem take on a reverse angle (specimen E) when he should make this member an exception (see specimen F). The distinctive mark at the left end of the horizontal member should be retained (as shown) as it prevents mistaking seven for one when it stands too close to the right of a five.

Eight would certainly be more distinctive and less likely to be taken for something else if it retained the stem used in script. Even when threes and fives are made as suggested, the beautifully rounded and symmetrical outlines of eight, as usually made, are not sufficiently characteristic for the purpose.

As made, the nine is perhaps the worst offender of all. Not only must it be helped out with prick-punch marks, dots and bars, but it is often so closed as to resemble its neighbor, the characterless character, eight. A straight stem nine has everything to recommend it from the shop man's viewpoint.

The writer hopes the foregoing may lead to a discussion of the subject. Its importance is not likely to be overestimated.

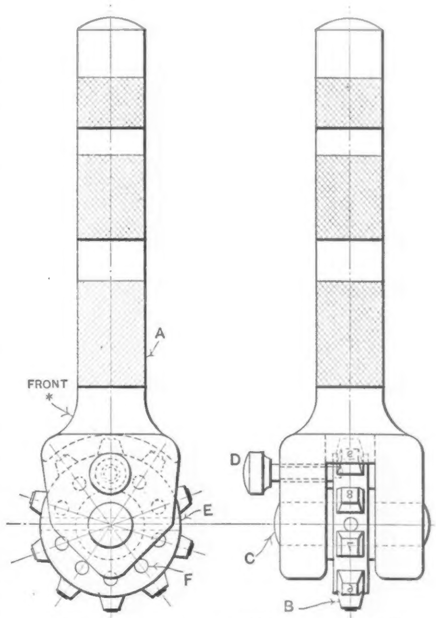
Wm. S. Rowell

Morton Park, Ill.

[The different styles of figures shown in Fig. 2, which is reproduced directly from a page of Gauss' logarithm tables, are commendable because of their clearness and dissimilarity, which tend to lessen mistakes. Figures of this kind are generally used in mathematical tables. It will be noted that there is a decided difference between all the figures, which are not only of a very open style, but, in some instances, of different heights as well.—Editor.]

NUMBERING TOOL

The numbering tool shown in the accompanying engraving is made to be used as if it were a single die. This tool will be found very convenient in the machine shop for numbering machine parts. The handle *A* is turned from tool steel and is hardened on the upper end. The hardened wheel *B* contains around its periphery the numbers from one to nine and a cipher. This wheel is fastened to shaft *C* by a pin *E*, which is driven through both parts. A screw *D* with a conical point fits in the holes *F* in the side of the stamp wheel, thus holding the latter in position when the tool is in use.



Numbering Tool with Rotary Stamp Wheel

This screw is hardened and knurled. Shaft *C* is casehardened and it should be well fitted to its bearings. Crossed lines or a star indicates the front of the tool so that the figures may be held right side up without any trouble. By combining the usual ten dies upon one wheel in this manner, a lot of useless handling is done away with and the work of numbering parts is greatly facilitated.

L. H. Georger

Buffalo, N. Y.

LAPPING OF SMALL HOLES

Mr. Crosby's article on lapping in the February number of Machinery reminded me of a personal experience in that line about three years ago. I was then a college student and spending my vacation in a small shop manufactur-

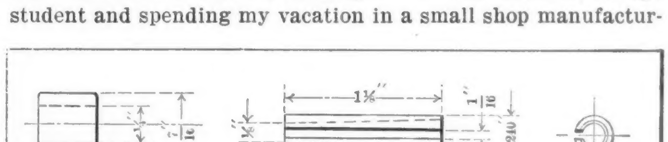


Fig. 1. Lap and Lap-arbor for Lapping Cam-roller shown at A

ing a special kind of sewing machine. The shop was not equipped as well as it might have been, and as a result the only manner of finishing the holes in the positive-motion camrollers *A*, Fig. 1, was by lapping. Hundreds of small shops all over the country finish work in this way.

The rollers were made in a screw machine and casehardened. An exact size for the lapped holes was not necessary;

what was wanted was a straight hole, entirely free from "bell-mouths." The amount of metal to be abraded in this manner was rather abnormal, ranging anywhere from 0.005 to 0.010 inch.

The lapping was done in an ordinary speed lathe, and the rollers were held by the three most useful fingers of the right hand. This latter circumstance, although inconvenient, was the only practical method that gave very satisfactory results.

A taper arbor *C* was chucked true in the lathe and was not removed while the lathe was being used for lapping. This arbor had a taper of ¼ inch per foot, the same as a standard taper pin. The laps, one of which is shown at *B*, were made out of solid brass rod. The arbor holes were drilled and reamed with an ordinary taper pin reamer. The

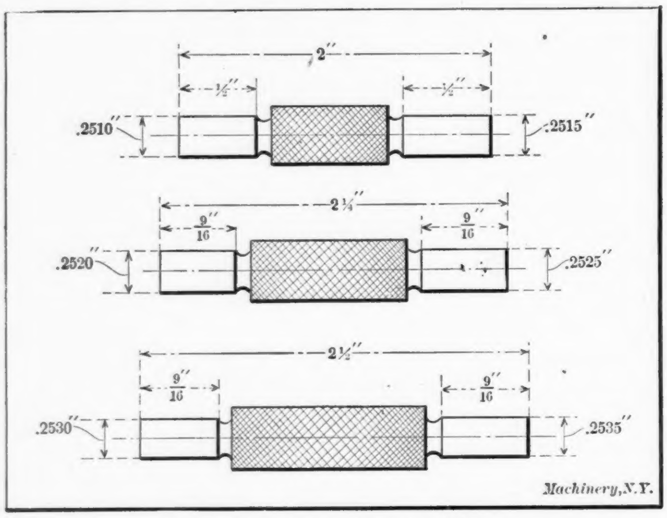


Fig. 2. Gages for Testing Lapped Holes

laps were then split while on the taper arbor, by means of a small square-nosed tool fixed in the tool-post and fed by hand, with the lathe spindle locked in place.

Three hardened and ground limit gages (Fig. 2) each end of which varied by 0.0005 inch, were constantly used during the process of lapping. Fine emery and oil served as an abrasive.

From time to time the laps had to be dressed with a file and tested with a pair of micrometers, as everything else being equal, "bell-mouths" were invariably the result of unevenly-worn laps.

The gages shown were made by the author from broken taps and milling cutter shanks, and they were machined and ground to size on a bench lathe. Not being very elaborate, they were made of varying lengths to prevent confusion.

Flint, Mich. M. Terry

CLEARANCE FOR BROACHES

There is one point in the article published in the January number of Machinery, engineering edition, on "Cutting Square Holes on a Keyseating Machine," upon which I cannot agree with the writer, *viz.*, giving no outside clearance to the teeth of a broach. The advantage gained by the support obtained with no clearance would be counteracted by the scoring of the work which would be caused by this type of broach, for immediately back of the cutting edge on each tooth, while cutting, the surface of the work is perfectly dry, and owing to this kind of broach never cutting to its full size the first time through the work, the friction caused by the hole being smaller than the back of each successive tooth and the dry surface of the work, prevents a good finish from being obtained.

Under the most favorable conditions, lubricating the cutting edges of these broaches is difficult, as each tooth of the broach is lubricated by the amount of lubricant carried in the flute cut to form the tooth; therefore the longer the hole to be broached of a given size, the less satisfactory the result will be, as the lubricant is used up before reaching the bottom of the hole, and if the tooth space is not of sufficient area to hold the chips accumulated, there is a tendency for the broach to seize.

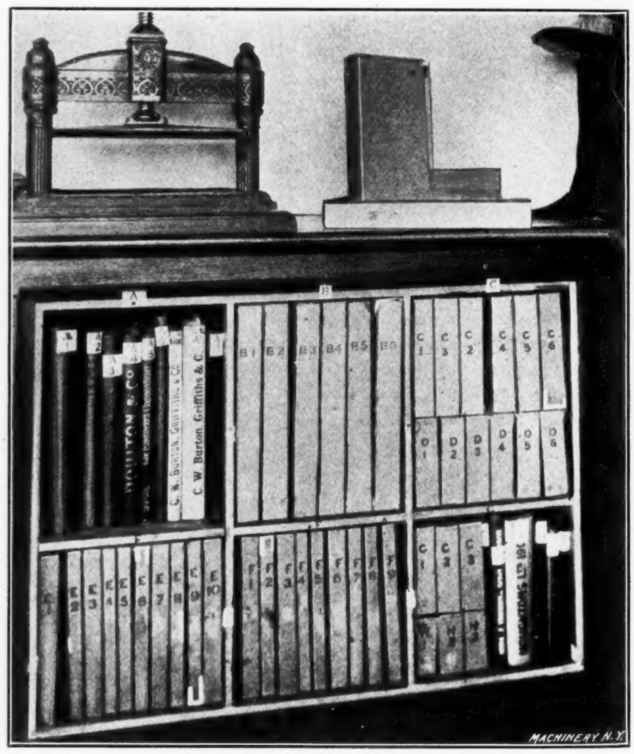
The style of broach that I have found most satisfactory in actual practice is made with a pilot 2 inches long, the diameter of which should be equal to the largest size of cutting edge on the broach. Each tooth should be relieved on the outside and undercut to form front rake; each tooth should increase in size 0.002 inch, except the last three teeth, which should be parallel and equal to the finished size of the hole. The area of each flute for each tooth should be as large as possible without making the tooth too weak to stand the strain of cutting. The diameter of the shank should be equal to the width across the bottom of the flute, of the largest tooth, and the length equal to the length of the hole in the work plus the depth of the guide hole in the ram of the broaching machine. W. C.

CATALOGUE FILING SYSTEM

I was greatly interested in the editorial in the November number of Machinery, describing a system of filing catalogues. At our works, for many years no attempt was made at systematic filing, and when a particular catalogue was called for, it was rarely forthcoming until a long search had been made for it. At last it became absolutely essential that some system of filing should be adopted.

First all dead and duplicate matter was removed, thus considerably reducing the number of catalogues to be handled. A number of cardboard boxes were then made, each measuring about 12 by 9 inches, with a width of 1 inch. The boxes were numbered and lettered at the back, and then placed in suitable pigeon-holes in a vertical position, as shown in the accompanying engraving. The letters corresponded with the pigeon-hole letters, and the numbers were run consecutively under each letter. Each box was then filled with as many books or leaflets as it would conveniently hold, each book being numbered and lettered the same as the box, in which it was placed. Large books were not put into the boxes, but simply placed on the shelves, library fashion, as shown.

As the boxes of the size given were found to be too deep



Cabinet in which Catalogues are filed

for small books, we had some made L-shaped. This allows easy extraction of the books, and at the same time keeps the backs of the boxes in line, thus preserving the neatness of the arrangement.

The catalogues were indexed in a card index under the firm names, and another index of subjects is being arranged as required. This latter index should be very valuable when more fully developed. The system is really very simple, costs little to install, and can be gradually introduced. The file is neat in appearance, and we have found it to answer its requirements admirably. C. J. Robertson

West Bromwich, England.

DANGEROUS OXY-ACETYLENE APPARATUS

Believing that you are desirous of informing your readers correctly, concerning the bad practices which are resulting disastrously to the oxy-acetylene industry, you are requested to publish the following communication. Realizing that some of your readers may possibly consider that the statements were inspired by a selfish interest, we invite a most searching investigation as to their correctness:

If the union of oxygen and acetylene did not produce an unusually powerful agent, the oxy-acetylene process would not have its present value. Acetylene is by far the richest of all gases in carbon, and combined with oxygen, produces much the hottest flame that has yet been created. It is generated from calcium carbide, which is nothing more than coke and lime combined at a very high temperature, but the finished product is as inert, and as little dangerous, as crushed stone, unless put in contact with water, and it can be subjected to any kind of rough usage without the least danger. Acetylene itself, can not be ignited without a mixture of air, or oxygen, unless it is compressed to more than thirty pounds pressure.

Chemically, oxygen is made from chlorate of potash, and similar materials, which are not dangerous unless placed in contact with carbonaceous matter, so that neither carbide, acetylene, nor the chemicals, are at all dangerous if they are properly handled; improperly treated, they can be made exceedingly dangerous, just as can ordinary coal, or water gas, or any of the hydro-carbons, such as gasoline, or oil.

The present acetylene generator is the evolution of various types that have been tested by years of use, and most of the earliest processes have been discarded by responsible manufacturers. Hundreds of thousands of acetylene generators are in use in the United States, and have become so important in the lighting industry, that they are the subject of yearly inspection by a body of engineers, in a laboratory which has been established by the National Board of Fire Underwriters. These engineers have become experts in the generation of acetylene, and have prescribed rules for the construction of such generators, which are the outcome of years of constant examination of apparatus of this character. Generators built in accordance with these rules, can be accepted by the public as desirable types.

These engineers, and the experience of a number of reputable manufacturers, have demonstrated beyond question, that what is known as the carbide-to-water types, are most desirable for the generation of acetylene. Carbide has what is termed "endothermic heat", which is similar to the heat of lime, when slaking, only the heat is much greater. One pound of carbide will boil six pounds of water; consequently the engineers for the insurance underwriters have a rule, requiring one gallon of water for each pound of carbide, which, it will be apparent, is sufficient to insure cool generation.

The types generally discarded are known as the water-to-carbide generators. The methods employed in this type were to sprinkle water on the carbide, or to flood compartments, or were of the recession type, where the water rose to the carbide and was forced back by the gas generated when the water came into contact with the carbide. All of these types are objectionable, because there is not a sufficient supply of water present for proper chemical reaction, and it is entirely absent so far as cooling is concerned. The result is that more or less gas is polymerized, or turned into tar vapors, by the excessive heat evolved locally, making a poor gas; and with rapid generation, there is danger of the heat becoming so great as to melt the portions of the generator in contact with the carbide, and to create danger of explosion should the generator be opened when the carbide is in this heated condition. Generally, the carbide is in the interior of the generator, surrounded by water, so that the heat is not perceptible from the outside of the generator, but it exists nevertheless.

Attracted by the supposed profits in the sale of oxy-acetylene apparatus, a new crop of generator makers, who are either unfamiliar with the established methods of generation, or unscrupulous, are springing into existence, and are placing these undesirable types on the market. They are doing exactly what was done with lighting generators, in the earlier part of of their history, until there became a great class of what was known as "tin can" machines, the poor results from which it took years of strenuous efforts by the better class of makers to overcome. These types of generators are even more objectionable for oxy-acetylene welding, than they were for lighting purposes, because the gas consumption is much more rapid, multiplying the bad effects from this improper generation. Should such generators be subjected to the inspection of the insurance engineers, they would unquestionably be promptly rejected.

Bad as is this method of gas generation, a still worse condition exists. It is known to those who are at all familiar with acetylene, that when it is compressed to from 30 to 45 pounds, or more, there is a kind of disintegration of the molecules, causing the gas to be explosive in the presence of a spark. In the early history of the art, some terrific explosions occurred from compressing acetylene in this form, and for a time its use under compression was entirely abandoned. Through a French discovery it was learned that if cylinders were completely filled with a porous material, and this material was then saturated with acetone, the acetone would dissolve the gas to twenty-five times its own volume for each atmosphere of pressure, and that when the pressure was relieved the acetone would give off the acetylene, and that this method not only gave the cylinders a marvelous capacity, but made it entirely safe to use acetylene in this form. The "Presto-o-lite" cylinders, which can be found on almost any automobile, are examples of what has been done in this line, and many railroad cars are lighted by this system. It is also employed quite extensively in oxy-acetylene welding for portable uses.

In the face of past disastrous experience, there are persons who are manufacturing acetylene by compressing it direct from carbide, without purification, and during the past year there have been several fatal accidents from this cause. In one case nine people were killed, and the directors of the International Acetylene Association held a special meeting, and passed resolutions condemning this process, which is nothing less than criminal to employ.

A method is being used to make apparatus portable, which is nothing more or less than to place an acetylene generator on an ordinary truck, and wheel it about. A generator in this position is not only likely to be accidentally tipped from the truck, but it may be placed in close proximity to red-hot furnaces, or struck by swinging cranes, or injured in many other ways, and it does seem as though any careful, thoughtful person could immediately realize the danger of such an arrangement. If the generator should be tipped over, it would immediately bring the whole body of water and carbide into contact, which would certainly burst the generator, and the volume of gas released might come into contact with fire, and an explosion follow. Obvious as is this danger, there are men in important mechanical positions to whom it did not occur until their attention was called to the possibilities. Certainly, no intelligent insurance representative would approve of such apparatus.

So far from acetylene being considered dangerous, when properly manipulated, the highest insurance authorities have concluded that it is much safer than movable units, such as lamps; and there is no reason why it should not be equally safe for oxy-acetylene purposes.

The conditions with regard to the generation of oxygen, are not much better. The desire of many persons, who can use the oxy-acetylene welding process to advantage, to obtain apparatus at very low cost, has proved to be a great incentive to constructing the apparatus cheaply.

Oxygen has been produced in this country for many years from chlorate of potash, and similar chemicals, but in such cases it has been the practice of the most prominent manufacturers to generate this gas under only sufficient pressure to wash it thoroughly, and force it into a gasometer, from which it is compressed by a compressor into tanks for portable use. It does not require much thought to realize that it would be much cheaper to generate the oxygen in the retorts, under sufficient pressure to force it into the tanks ready for use. This would cut out large washers, the gasometer, and the most expensive part of the plant, the compressor; such a plant could be built at small cost, and at considerable profit. That this is

being done, and advertised quite extensively, requires only the examination of the advertising columns of a number of trade papers to show.

The most approved types of plants generating oxygen from chemicals, have the compressors built with two stages of compression, with an intercooling coil between the cylinders, and with the cylinders totally submerged in water, so that even though there are impurities in the gas, there is not sufficient heat generated to ignite the mixture. It is also required that the parts of these compressors subjected to oxygen, must be of non-corrosive metal, which adds still further to their cost. It will be evident that plants not having these necessary requisites, can be, and are sold, for much less than properly constructed apparatus.

Defective and dangerous types of oxy-acetylene apparatus have not, as a rule, given satisfactory results and tend to discredit the process. Such apparatus has injured the art not only in this country, but in Europe as well. Solicitations have been received by the company which the writer represents, to sell its apparatus in Austria, by a very prominent firm, whose letter states that that country has numerous cheap and ineffective plants, which have brought the process into disrepute.

Augustine Davis,
New York. President Davis-Bournonville Co.

THE DIFFERENTIAL SCREW FALLACY

I notice an article in your April number (page 647, engineering edition) on the Derihon testing machine, and without criticising the principle upon which it is based as giving more or less reliable indications of hardness, I am very much surprised to see, in this age of enlightened mechanics, the old-fashioned device of a differential screw adopted as a means for increasing power. The earlier text-books on mechanics estimated the force exerted by a screw from a comparison of the distance traversed by the hand lever and the corresponding advance in the screw, and, by the same method, the differential screw was shown to have wonderful possibilities. But no allowance was then made for friction, which has since been shown to eat up about 90 per cent of the power applied to standard bolts and nuts, and, as a matter of fact, it has been demonstrated practically as well as theoretically that the pitch of a screw has very little effect upon the pressure exerted by a given force at a given distance from its axis.

It is high time, therefore, for the differential screw fallacy to be exploded, and without knowing the exact details of construction, I feel very safe in asserting that the pressure exerted by the differential screw in this case is no greater than the pressure that could be exerted by the screw *C* alone if attached directly to the handle bar *M*.

I came to the conclusion about thirty years ago that differential screws never accomplished any useful purpose, and established this fact by experiments as well as by analysis. Later in 1891, "Some Experiments with a Screw Bolt" was reported to the American Society of Mechanical Engineers, which confirmed my own experience, and in discussing this paper, I gave a general analysis of the power of screws as affected by friction.

Experiments on the friction of screws were again reported to the same society in 1895, and it should be more generally understood how little the pitch of a screw really has to do with its power. This really depends more upon the relation between the diameter of the screw and the length of the lever arm to which it is attached than it does upon the pitch of the screw, and it makes little difference whether the advance of the screw comes from a single thread or from the difference in the pitches of two threads combined.

There may be instances in which differential screws can be used to advantage for the purpose of reducing velocity ratios, but when used for the purpose of increasing power they are, and always have been, a mechanical absurdity.

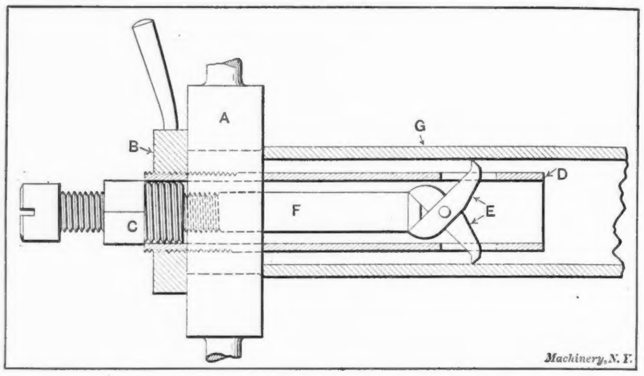
Wilfred Lewis,
Philadelphia, Pa. President Tabor Mfg. Co.

[The use of the differential screw principle in the Derihon apparatus enabled the designer to provide a thrust bearing of comparatively large area and small pitch diameter. A swivel and suitable thrust bearing would have been necessary if *M* were mounted on *C*, in order that the steel ball *B* may not rotate when in contact with the piece being tested. The efficiency of a screw thrust bearing designed like this in the Derihon apparatus is undoubtedly much higher than that of a plain thrust bearing of equal diameter. We agree with Mr. Lewis that the efficiency of differential screws in general, is very low.—Editor.]

PIPE FITTER'S KINK FOR STARTING DIES

While in a pipe fitter's shop recently, the subject of threading pipe came up, and the man of the shop showed me the device shown in the sketch which he said had helped him in threading pipe that was hard to start the thread on.

In this case the part *D* is a piece of ½-inch pipe about six inches long with a thread cut on the outer end about two or three inches; *C* is an ordinary plug with a hole through the center, through which a 5/16-inch rod is screwed, the plug



Device for Starting Dies on Pipe

being screwed in the end of the ½-inch pipe; *E* are steel jaws pivoted, as shown, and forced outward through holes cut in the sides of the ½-inch pipe; *B* is a plate with a handle, which is screwed on the outer end of the ½-inch pipe, and *A* represents the die used in threading the pipe *G*. By screwing the rod *F* either with a wrench or screw-driver, the jaws are forced outward against the inside of *G*; then by screwing the die and the plate *B* at same time, the die will start the thread in a very satisfactory manner. The device is easily removed by unscrewing the rod *F*. X. Y. Z.

LOOSE CORRESPONDENCE METHODS

Americans would sell more machinery abroad if they were less "slap-dash." I write, say, to the Robinson Lathe Co. asking who is its German representative; in the meantime the company changes to the United States Machinery & Mfg. Co., or some such name, and answers under that head simply: "Our German agents are Blank & Bros." I have no letter copy with the U. S. M. & M. Co. so their statement does not interest me a little bit. Later I write a second letter to the R. L. Co. and get a second reply from the U. S. M. & M. Co. again without any reference to the R. L. Co. This is a common experience. Also, young firms with high-sounding names advertise or their products are described, without any street address; and inquiries come back stamped "Unknown." The Niles-Bement-Pond Co. needs no street address; but the Universal Machine Tool Co. and the General Mfg. Co. do. Robert Grimshaw

Dresden, Germany.

POINT IN GAS ENGINE PISTON MANUFACTURE

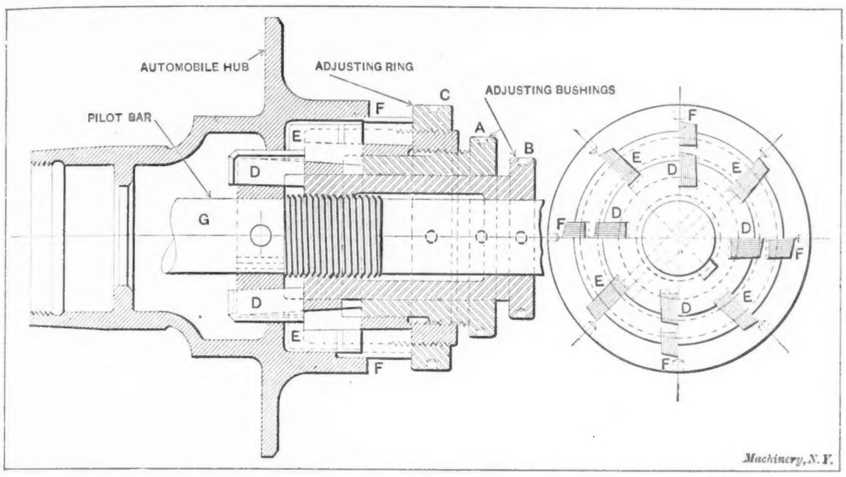
The article in the April number of Machinery about machining gas engine pistons, does not bear out my experience in such matters. In my experience the boss cast on the closed end of the piston to hold it by when turning, would have a mushy center where cut off. This would be the worst possible thing to have on a gas-engine piston, making a weak end, and giving a ragged surface, causing premature ignition. There would also be a chance of loss in work and material, as cutting off this boss is the last of a series of operations. Our company does not permit a piston to pass, having a rough or porous end; we also chill all pistons over the ring grooves.

Oil City, Pa. John Reid

AN ADJUSTABLE BORING-HEAD

A design of adjustable boring-head which can be used for boring three different sizes at once is shown in the engraving. The particular tool illustrated is intended for boring out the axle hubs of automobiles. The body of the boring-head is of cast iron, and it contains, as shown more plainly in the end view, three different sets of blades for reaming a corresponding number of diameters in the hub. The blades fit into slots which should be dove-tailed to an angle of from 3 to 5 degrees to prevent the blades from lifting out of the head. The bottoms of these slots are also tapered, as shown in the sectional view. The blades, of course, have a corresponding taper so that by changing their longitudinal position they may be set to different diameters. The body of the reamer is attached to a pilot bar *G* by a taper pin or key. This bar is threaded (16 threads per inch), as shown. Adjusting bushing *B* is an accurate fit over the bar on one end, and is threaded to it on the other. The recess which is cut into this bushing is to do away with the long bearing and to lessen the length of the threaded part. A second adjusting bushing *A* is accurately fitted over *B*. The outside of this second bushing is threaded into the reamer body, and it is also a close running fit on the end. The last adjusting bushing is threaded to the outside of the reamer body. As will be seen, any one of the three sets of blades may be adjusted independently. For example, by screwing in bushing *B*, the four blades *D* could be adjusted out to any dimension within the limits of adjustment. Similarly, by turning bushing *A* or *C*, the blades *E* or *F* may be adjusted, respectively. These blades are made of the best tool steel and they should be a snug fit in the head. They can be ground to take an end cut when this is necessary.

Pawtucket, R. I. HAROLD E. MURPHEY

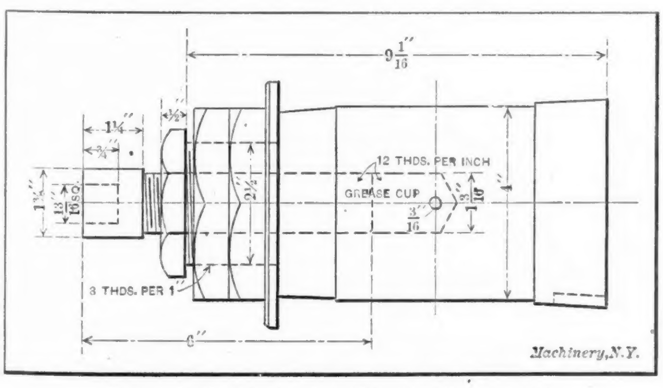


Adjustable Boring-head for Machining Three Different Diameters Simultaneously

GREASE CUP IN THE WRIST-PIN

A grease cup that is made by boring a hole in the center of the wrist-pin and screwing in a plug which has a square recess which will take the regular grease cup wrench is shown in the engraving. A lock-nut is provided to prevent the plug from working loose. Regular hard grease is used. Two holes are drilled in the wrist-pin, one in the front and one in the back, and oil grooves are cut in the connecting-rod brasses. This plug is the design of Mr. Charles Cotter, traveling engineer for the Duluth and Iron Range R. R., and it has been used on the engines of this road for a number of years, giving great satisfaction. AUSTIN G. JOHNSON

Two Harbors, Minn.



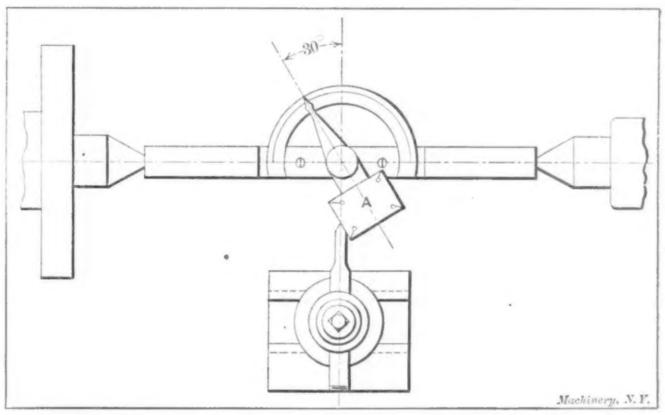
Locomotive Wrist-pin with Self-contained Grease Cup

TINNING STEEL PANS

In answer to the question by G. S. on the How and Why page of the February number of MACHINERY relative to the tinning of steel pans, I would suggest the following, which I tried with good results: In tinning sheet metal, if the parts are scaly, they should first be sand-blasted or pickled so that the tin will adhere properly. Before tinning, they should also be put into a muriatic acid bath. The parts are then dipped into melted tin, removed and plunged into oil while still hot (we use melted tallow). They are then re-dipped into the tin; this second dipping gives a thicker and heavier plate. The oil acts as a flux which gives the tin plating a brighter and smoother finish. After the pieces have been dipped a second time, they are put onto racks to drip until cold. The cast-iron pot or vat in which the tin is melted, should be about 12 inches deep and several inches wider and longer than the pans. Wire hooks are used when dipping the parts to be tinned; the pieces should be perfectly dry before they are placed in the molten metal. J. S. S.

COMBINATION TEST BAR AND PROTRACTOR FOR THE LATHE

A combination test bar and protractor intended for use in the lathe is illustrated herewith. It is quite difficult when the cutting edge of a tool is to be set to a certain angle, to hold an ordinary protractor with one hand, and adjust the tool with the other. With this device the protractor is set to the required angle and then the tool is adjusted to one of the hardened edges on the rectangular piece *A*. The edges of this rectangular piece are ground after the tool is assembled, thus insuring their accuracy. The cylindrical part on which the protractor is mounted is hardened and ground so that it may be used as a test gage. When the protractor is being set, the lathe centers are tightened just enough to hold it in position so that the workman has both hands free for setting the tool. The small slots in the corner of the piece *A* were cut in to prevent it from cracking during the hardening operation.



Protractor for Setting Lathe Tools, which is mounted on Hardened and Ground Test Bar

This protractor may be used to advantage for setting lathe tools when making angular cutters for the milling or screw machine or when making bevel or miter gear blanks, and for setting threading tools for either internal or external threading. E. E. MARTIN

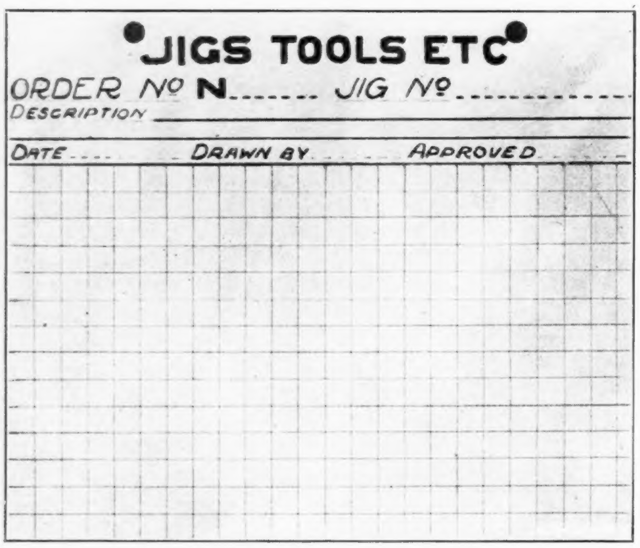
Providence, R. I.

SIMPLE METHOD OF MAKING BLUE-LINE PRINTS

Some time ago the writer found that it would be a great convenience to have a number of forms, but as these were to be used in small quantities it was hardly advisable to have them printed. Blueprints with blue lines upon a white field was just the thing, and a very simple method of making them was found, which will possibly be of interest to other draftsmen.

A negative was prepared as follows: A piece of tracing cloth somewhat larger than the desired size was placed upon a smooth board with the dull side of the cloth exposed, and the edges tacked securely. Two thin coats of black shellac varnish, such as is commonly used by pattern-makers, were applied to the cloth, so as to make it perfectly opaque. The shellac was allowed to set for about an hour, so that it was thoroughly dry, but not long enough to become brittle, and then the tracing cloth was removed and placed upon the drawing board with the varnished side up. The desired lines were then laid out upon the tracing cloth by rubbing it thoroughly with soft white chalk, and then drawing the lines upon it with a lead pencil, the pencil point leaving a black line where it removed the chalk from the black surface. The letters and figures desired were laid out in the same way. The ends of a piece of wire about six inches long were then ground down to a sharp point, one end being flatted slightly on an oilstone. The lines in the chalk were then traced over with the sharp point of this wire so as to scratch them evenly through the shellac. The letters were also outlined with the sharp point of the wire, and then the shellac inside these outlines was scraped off with the flat end of the wire. The shellac was found to come loose very readily, so that with a few minutes' practice letters could be formed that looked fairly presentable, almost if not quite as easily as they could be made with an ordinary pen upon tracing cloth. The chalk was then removed, and after trimming, the negative was ready to make blueprints from.

The accompanying illustration shows a blueprint that was


JIGS TOOLS ETC
ORDER No N....... JIG No.............
DESCRIPTION
DATE .... DRAWN BY .... APPROVED ....

Print with Blue Lines on a White Sheet

made from a negative which was the writer's first attempt along this line. This negative has been in use for quite a long time, possibly two hundred prints having been made from it, and it shows no signs of wear. By referring to the engraving it will be noticed that the cross lines in the body of the print are lighter in color than the heading, so as not to obscure the writing and sketches made upon it. This was accomplished by placing a piece of thin bond paper in front of the negative when printing.

This method has been used by the writer in preparing forms for monthly labor records, monthly reports, shop sketches, etc. Of course it is hardly applicable to the preparation of complicated drawings, and possibly could not be recommended for forms having a great deal of small lettering or figuring upon them, but for plain ruled forms with fair-sized letters, it does very well.

It was mentioned previously that the shellac should not be allowed to set long enough to become brittle before finishing. The reason for this is that when the shellac becomes brittle it will chip away when scratched, making it impossible to get satisfactory results. BRUCE C. MCALPINE

Jackson, Mich.

DIVIDING A CIRCLE INTO EQUAL PARTS

A simple method of dividing a circle into any number of equal parts is shown in the accompanying illustration. To divide any circle, draw a line *A-B* from *S* at any convenient angle with *L-S*; then divide *A-B* into the number of parts that the circle is to be divided into. Draw from the last point *G* a line *D-C* through *L*. Count down two divisions from *G* on *A-B* to *E*, and draw *E-F* parallel to *C-D*. Strike two arcs at *H* from points *L* and *S* and with *L-S* as a radius. Then draw the line *N-K* through point *P;* the point of intersection *M* will then be the first point on the circle; in other words, arc

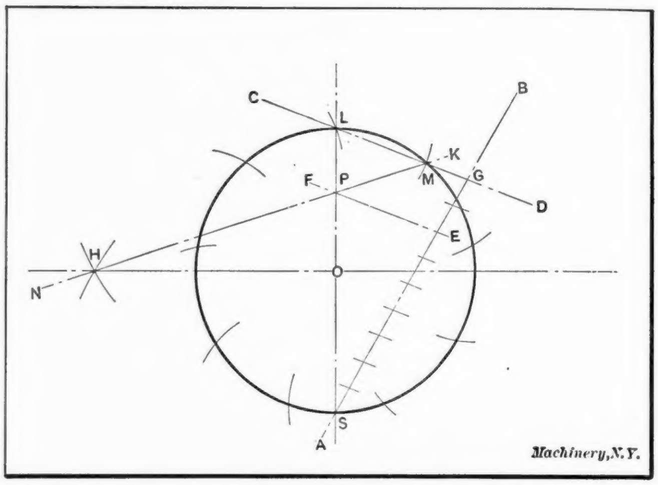


Diagram for Dividing a Circle into Equal Parts

L-M is one division of the circle. Of coure I do not claim to be the originator of this method of dividing a circle; it is, however, so simple that it will doubtless be appreciated by those who have not been familiar with it. ROBERT WILKINSON

Buffalo, N. Y.

[We will be glad to receive from any of our readers the geometric proof of this method of dividing a circle, which will doubtless be of general interest.—EDITOR.]

FINISH ON IRON CASTINGS

In the February number, E. S. S. asks through the How and Why page for a good method of securing a glossy enameled finish on iron castings. Two methods are given in the following, which I have used with good results, after a long search for suitable preparations:

For a fine, rich, black gloss, I use Minett's air-drying black varnish, which can be obtained from almost any wholesale paint and oil store. Two or three coats of this varnish should be applied; it dries quickly and when dry becomes hard. It will weather longer than any preparation that I know of, and it also fills the pores and will not break out in streaks. This varnish is cheap, and it gives a rich, bright gloss to the work.

When castings are very porous, the following preparation may be used as a filler to obtain a smooth surface: For one quart of this filler mix one-half pound of white lead, one pound of whiting and one gill of varnish, with enough turpentine to properly thin the filler. The white lead is to bind or hold the mixture together, the whiting is for filling the pores, and the varnish is to give a glossy finish. After putting on one coat of the filler, a coat of ivory black should be applied, and then a coat of varnish. This finish is not as cheap as when the black varnish is used, but it is a good one and lasting.

The gray or streaked spots, referred to by E. S. S., which appear on malleable castings are very common, especially after certain metals have been plated. Some experts claim that it is the pickling acid working out of the pores, and I am inclined to believe that this is the trouble. The Platers' Organization of America has, I understand, this same question under dis-

cussion at the present time, but as yet no one has explained how to prevent these streaks from showing. Poor oxidization will also aid in causing the streaks to appear on account of the rough porous surface which contains so many small cavities that secrete the acid. J. S. S.

IRREGULAR SPACING FOR REAMERS

The accompanying table will be found useful in fluting reamers with irregularly spaced cutting edges. All even numbers of flutes from 4 to 24 are given in the column to the left, and the number of turns of the dividing head crank to be made when indexing for each flute are stated in the body of the table. For four flutes, two sets of figures are given, one

IRREGULAR SPACING FOR REAMERS

Table is for one-half the reamer; repeat the same movements for other half

No. of Flutes	Turns for Dividing Head											
4	$9\frac{3}{4}$	$10\frac{1}{4}$	Under 2 inches diameter									
4	$9\frac{1}{2}$	$10\frac{1}{2}$	Over 2 inches diameter									
6	$6\frac{1}{3}$	$6\frac{2}{3}$	7									
8	$4\frac{1}{4}$	$4\frac{3}{4}$	$5\frac{1}{4}$	$5\frac{3}{4}$								
10	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5							
12	$2\frac{4}{5}$	3	$3\frac{1}{5}$	$3\frac{2}{5}$	$3\frac{3}{5}$	5						
14	$2\frac{3}{7}$	$2\frac{4}{7}$	$2\frac{5}{7}$	$2\frac{6}{7}$	3	$3\frac{1}{7}$	$3\frac{2}{7}$					
16	2	$2\frac{1}{7}$	$2\frac{2}{7}$	$2\frac{3}{7}$	$2\frac{4}{7}$	$2\frac{5}{7}$	$2\frac{6}{7}$	3				
18	$1\frac{7}{9}$	$1\frac{8}{9}$	2	$2\frac{1}{9}$	$2\frac{2}{9}$	$2\frac{3}{9}$	$2\frac{4}{9}$	$2\frac{5}{9}$	$2\frac{6}{9}$			
20	$1\frac{11}{20}$	$1\frac{13}{20}$	$1\frac{15}{20}$	$1\frac{17}{20}$	$1\frac{19}{20}$	$2\frac{1}{20}$	$2\frac{3}{20}$	$2\frac{5}{20}$	$2\frac{7}{20}$	$2\frac{9}{20}$		
22	$1\frac{4}{11}$	$1\frac{5}{11}$	$1\frac{6}{17}$	$1\frac{7}{11}$	$1\frac{8}{11}$	$1\frac{9}{11}$	$1\frac{10}{11}$	2	$2\frac{1}{11}$	$2\frac{2}{11}$	$2\frac{3}{11}$	
24	$1\frac{5}{24}$	$1\frac{7}{24}$	$1\frac{9}{24}$	$1\frac{11}{24}$	$1\frac{13}{24}$	$1\frac{15}{24}$	$1\frac{17}{24}$	$1\frac{19}{24}$	$1\frac{21}{24}$	$1\frac{23}{24}$	$2\frac{1}{24}$	$2\frac{3}{24}$

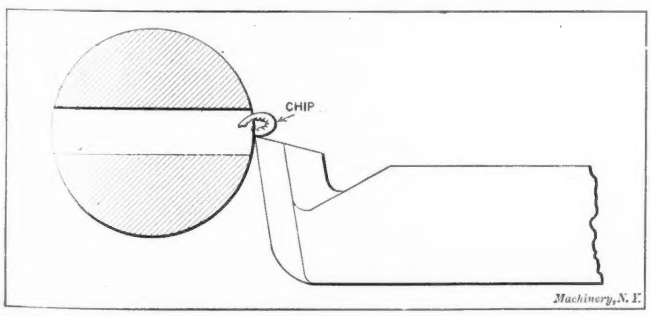
when the diameter of the reamer is under two inches, and one when the diameter is over two inches. The table gives the movements for the spacing of half the reamer only; then the same movements are repeated for the other half.

Freeport, Ill. D. O. Barrett

[This method of indexing, it will be noted, makes the two halves of the reamer exactly alike, and opposite cutting edges are exactly in line, that is, they are not off-set or "broken up." An article is published in another part of the paper regarding the practice of irregular spacing for reamers, where the subject of "breaking up the flutes" is more thoroughly treated. —Editor.]

FINISHING SLOTTED COLLETS IN THE LATHE

A small shop received an order for a number of Brown & Sharpe collets (No. 7 inside taper and No. 9 outside taper). There being no grinder to finish the outside diameter, it



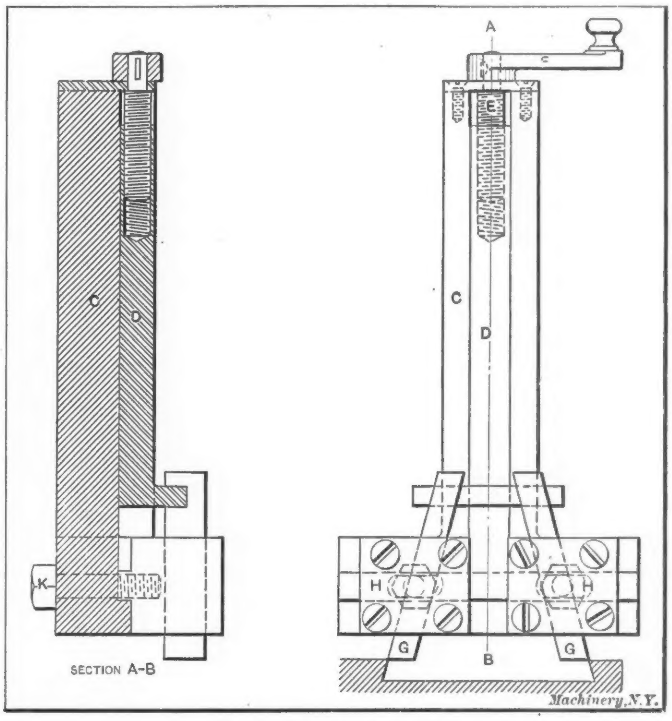
Sectional View of Slotted Work showing Chip Interference when Tool is crossing Slot

meant that the collets must be rough- and finish-turned in the lathe. As the work had to be accurately done, it occurred to me that if the collets were finished and polished before the drift slot was cut, they would be bruised while this was being done, which would make it necessary to go over them again; therefore, I concluded when turning them to allow 1/32 inch above the largest size for finishing after the slots were cut, and to make them straight. When turning these collets after the drift slots had been finished, I noticed that when my turning tool reached the slot, a deep groove was left on one side of it, but when the tool had passed the slot, it cut smoothly. The cause of this trouble was as follows: When the tool reached the drift slot, and as the point left it on one side, a chip was balancing itself on the point so that when the opposite side of the slot reached the tool the chip was between the tool and collet which caused the groove. The relation between the chip, the tool, and the work will be understood by referring to the illustration. Invariably on each succeeding turn of the collet this groove was formed on one side. By driving a piece of hardwood in the slot the trouble was overcome. The wood should not be driven in too tightly, as it may spread the metal on either side of the slot. This wood was also an advantage in filing, as the file did not leave a flat on either side of the slot, as is usually the case.

Covington, Ky. Robert Lang

TOOL FOR PLANING DOVETAILS

A tool for planing dovetails is illustrated herewith. This tool was designed by Mr. C. H. Marsh, foreman of the planing department in the works of Fay & Scott, Dexter, Me. It is



Tool for Planing Dovetails

used principally to plane the dovetail ways in lathe aprons, in which the lead-screw nut slides. When the tool is in use, the shank *C* is held in the clapper-box of the planer. When the cutters are to be set for planing a dovetail of a given size, the lever *F* is turned, thus moving slide *D*, which, in turn, moves the cutters *G* up or down until they are set to the required width at the top of the dovetail. The head is then raised or lowered until the tools just brush the work; they are then fed into the dovetail by turning lever *F*, the movement of each tool being, of course, on an angle corresponding to its angular position in the blocks *H*. Perhaps a better adjustment of the cutters is secured by loosening bolts *K* and moving the blocks *H* in or out, thus keeping the cutters closer to the tool body. J. Gray Card

Dexter, Me.

* * *

CORRECTION

An error occurred in the wiring diagram No. 7 for shunt reversing motors, Machinery's data sheet for March. The connections for the fields are tapped in on the same side of the line, so of course, there could be no field. One connection for the field should be shown transposed to the opposite side of the line.

HOW AND WHY

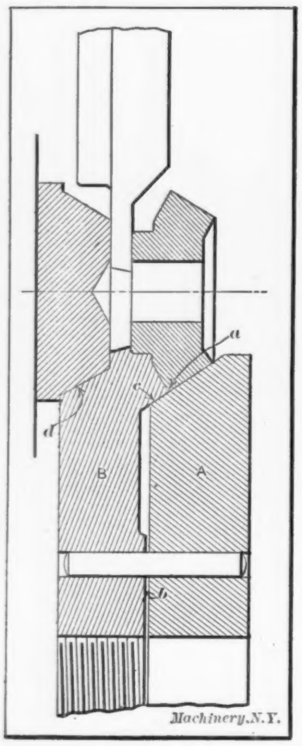
A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

FORMING TOOL FOR BEVEL GEAR BLANKS

H. M.—Kindly give me through the columns of MACHINERY some information relating to the designing of a tool for forming the outside angular surfaces of small bevel gears on automatic screw machines.

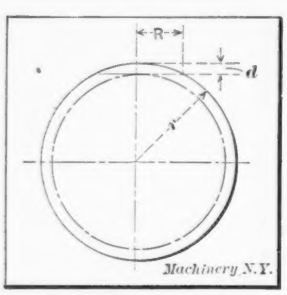
A.—The forming tool for forming the outside angular surfaces of a bevel gear can best be made as shown by the accompanying illustration. The forming tool consists of two sections *A* and *B*, doweled together. Two fillister head screws, not shown in the illustration, are also used for clamping the sections together. When grinding the two sections, allowance should be made so that a slight clearance of about 0.002 inch is allowed between the parallel faces at *b*; then, when the tool is fastened in the tool-holder, the clamping screw will entirely close any space at point *a*. When grinding the inside face *c* of section *B*, the angle should be somewhat less than the corresponding angle on the part *A*, so that the sections will fit very tightly at *a*. The angular surface at *d* takes a roughing cut on the next piece. The calculations necessary for forming tools of this class were quite fully treated in an article on circular form and cut-off tools in the April issue of MACHINERY, so that it will not be necessary to deal with this question here. It may be mentioned, however, that the face of the section *A* when cut down below the center, would theoretically be slightly concave, but the amount would be so slight that it would be imperceptible, and of no account in practice. When an absolutely true taper is required, a circular forming tool cut down below the center should not be used, but instead a taper turning box tool or a taper turning attachment, operated from the cross-slide. A so-called dove-tail forming tool is also sometimes found convenient. All of these methods have been used to good advantage.



THREAD ROLLING IN AUTOMATIC SCREW MACHINES

J. G. S.—I would like some information relating to thread rolling on automatic screw machines; in particular, I would like to know about methods used for making the rolls for thread rolling on this class of machines.

A.—The Brown & Sharpe Mfg. Co., Providence, R. I., states regarding the method of determining the pitch diameter for rolls for thread rolling in the automatic screw machine, that it is the practice of this company to first determine the pitch diameter of the piece to be rolled and then to deduct from it 1/6 of the double depth of the thread, and to use the constant thus obtained as a multiple for determining the pitch diameter of the thread roll. In general, a thread roll is made of a diameter about three or four times the diameter of the piece to be rolled. In such cases it is, of course, necessary to provide the roll with a triple or quadruple thread, as the case may be, in order that the angle of the thread on the roll shall be the same as the angle of the thread on the piece to be rolled.



The hand of the thread on the roll must be opposite to that of the thread to be rolled. A little consideration will easily make this clear. The calculation of the diameter of the roll should be based upon the pitch diameter of the thread to be rolled, and not upon the root diameter as has sometimes been done and which gives unsatisfactory results. The angle of the thread of the roll must equal the angle on the piece to be threaded, and when the diameter of the roll is a certain multiple of the diameter of the piece being threaded the roll must be provided with a multiple thread corresponding to the rate of increase. The diameter of the thread roll is found from the formula:

$$d = N\left(D - \frac{C}{6}\right)$$

in which d = pitch diameter of thread roll,

N = approximate ratio between pitch diameter of roll and pitch diameter of piece to be threaded,

D = pitch diameter of piece to be threaded,

C = double depth of thread.

As an example, assume that we wish to roll a piece 0.372 inch in diameter with 16 threads per inch, this being a No. 24 A. S. M. E. standard screw. The pitch diameter of this screw is 0.3314, and the double depth of thread equals the outside diameter minus the root diameter, or $0.372 - 0.2908 = 0.0812$ inch. Assume that the diameter of the roll will be made approximately twice the diameter of the screw. Then:

$$d = 2\left(0.3314 - \frac{0.0812}{6}\right) = 0.6357 \text{ inch.}$$

The roll will also have a double thread of ⅛ inch lead, and the outside diameter will equal:

$$0.6357 + \frac{0.0812}{2} = 0.6763$$

and the root diameter:

$$0.6357 - \frac{0.0812}{2} = 0.5951$$

Rolls made according to this formula have given good satisfaction. When rolling a thread on the Brown & Sharpe automatic screw machines, the following points should be taken into consideration: 1. The thread rolling tool-holder should be fastened to the cross-slide which carries the cut-off tool so that the piece will be severed from the bar before the roll returns. 2. The roll should be fed to the work in the same manner as a knurl. 3. The roll should be brought to within 0.010 inch from the piece on the quick rise of the cam, then fed the distance *R* in the accompanying engraving at a certain number of thousandths inch per revolution, and then released from the work by a quick rise of the cam, at the same time bringing the cut-off tool in position. 4. The feed per revolution for thread rolling is practically the same as for knurling, a table for which was given in MACHINERY, July, 1909, engineering edition. The formula for calculating the rise on the cam for thread rolling is given below; in the accompanying engraving, let

r = radius of piece to be threaded,

d = depth of thread,

R = rise on cam.

Then

$$R = \sqrt{r^2 - (r-d)^2} + 0.010.$$

* * *

In a paper by Mr. W. L. R. Emmett on the application of electricity to the propulsion of naval vessels, read before the American Association of Naval Architects and Marine Engineers, the author states that the efficiency of a turbo-electric installation on board ship can be brought up to 92 per cent, and he also expressed his opinion that no other form of speed-reducing gear between the turbine and propeller could be made to show as high an efficiency. Recent tests, however, on the Mellville-MacAlpine turbine reducing gear, illustrated in the February issue of MACHINERY, engineering edition, shows an efficiency of 98½ per cent.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the current month.

LANDIS HEAVY-DUTY PLAIN GRINDING MACHINE

The accompanying illustrations show a new self-contained plain grinding machine of large capacity (16 inches by 72 inches) built by the Landis Tool Co., of Waynesboro, Pa. As will be explained later, it is designed to be fitted with special appliances for chilled roll grinding; it will also be furnished with provisions for taking work such as pistons or rods, and similar parts met with in railroad shops. It is essentially, however, a plain grinding machine, of high power for heavy-duty operation, fitted for hard service in manufacturing work.

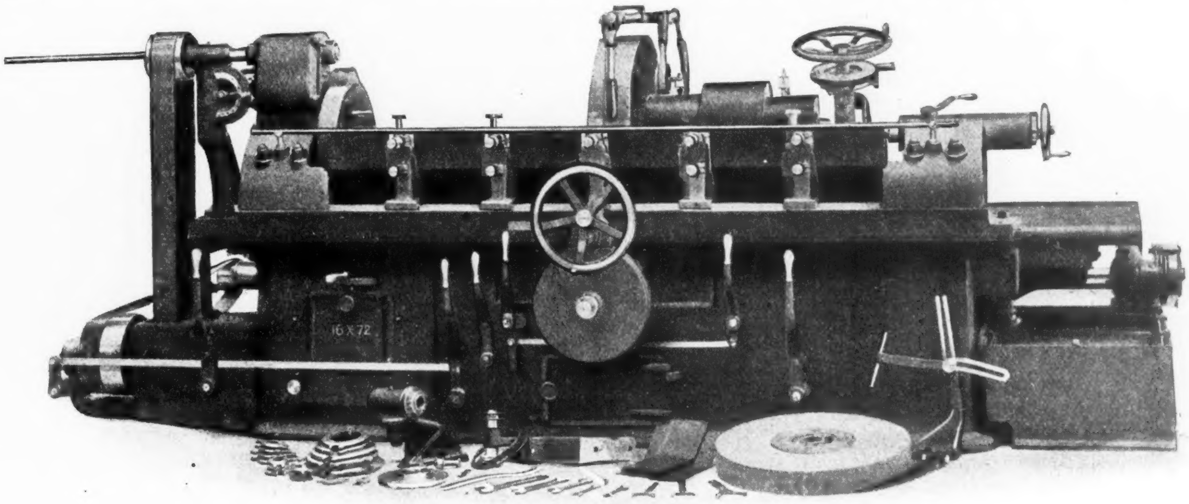


Fig. 1. Landis 16- x 72-inch Plain Grinding Machine for Heavy Duty

All the conveniences of the older design have been retained. The machine is of the traveling wheel type, with headstock and footstock mounted solidly on the stationary base of the machine. Quick-change, geared speeds for the work, and feeds for the wheel traverse, are provided. The geared feed can be operated automatically, and is provided with an automatic stop. The controlling handles are all reached from the front of the machine. The work speed and wheel feed are started and stopped together by a clutch in the pulley at the end of the feed box at the left of Fig. 1. These drives can also be operated separately, and their speeds are varied entirely independently of each other.

A new and interesting feature of the design is the drive for the wheel spindle. This is best seen in the rear view of the machine in Fig. 2. The power is applied to the large driving pulley at the right, mounted on the heavy main driving shaft, running the length of the machine. This shaft has keyed to it a pulley, mounted in a carriage on rollers as shown, which is connected with the driving wheel slide by an arm so as to always keep in alignment with it. A belt runs from this pulley over a series of idlers and over the pulley on the grinding wheel spindle. These intermediate pulleys are so arranged as to automatically take up any change in the belt length, and at the same time keep it under uniform tension. Almost two hundred degrees of contact are provided on both the driving and driven pulleys. The six-inch belt can stretch about eight inches in length before it is necessary to remove a section to shorten it.

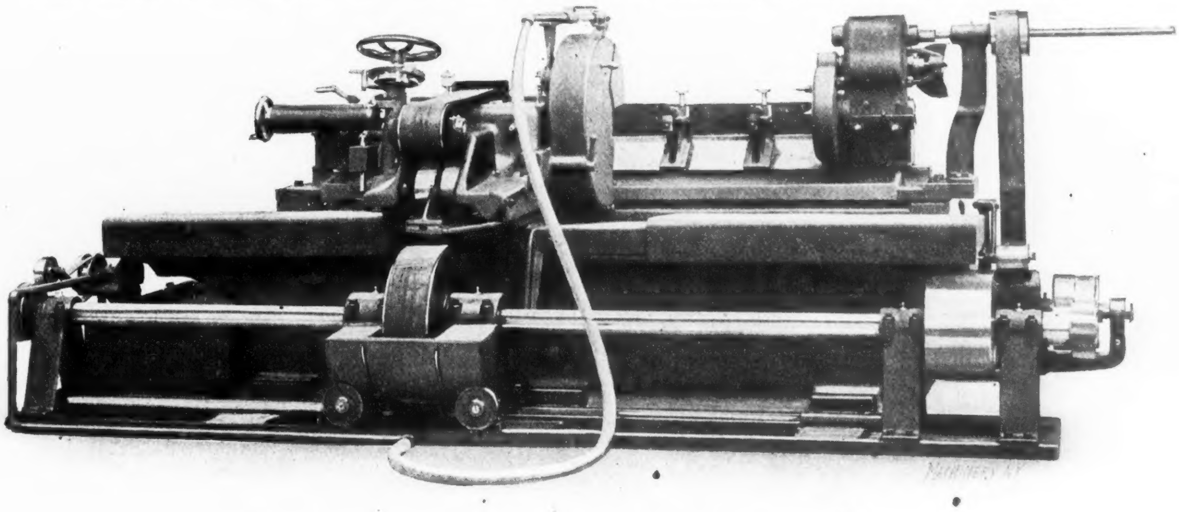


Fig. 2. Rear View of Landis Grinding Machine, showing Self-contained Drive

The movement of the driving wheel carriage along the main shaft in unison with the wheel slide is made easier by the method of keying the driving pulley to the shaft. This "key" is in the form of rollers in the hub of the pulley, engaging stepped grooves on the driving shaft as seen in Fig. 4. This does away with the heavy frictional resistance to sliding motion which would be felt if the pulley were keyed to the shaft as usual, especially when driving under a heavy strain. The mounting of the pulley carriage on rollers, in addition to this, gives perfect freedom of movement.

Great care has been taken to give the grinding wheel head the massiveness and rigidity required for the rapid production of accurate work. The spindle is of very large diameter, and is made of hardened steel. The bearings are phosphor-bronze; they are self-aligning and are adjusted in taper bearings to take up the wear. Self-oiling boxes are furnished. The very important feature of protecting these bearings from grit and emery has been attended to, positive dirt-

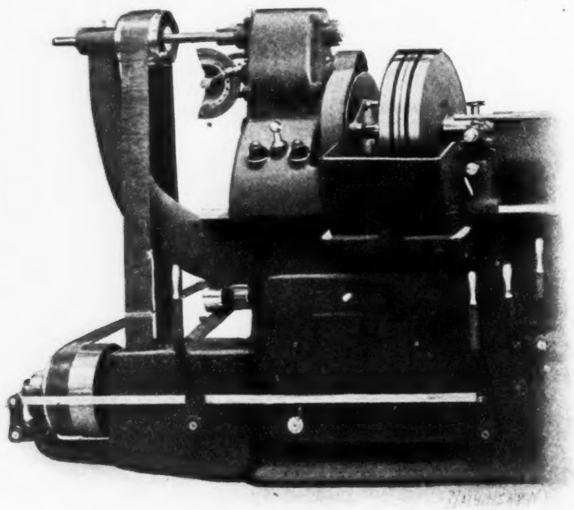


Fig. 3. Heavy-duty Grinder with Gap in Bed, for Railroad Work, etc.

proof covers being used for the purpose. The wheel collar is provided with an angular groove on its face, in which two weights are adjustably mounted. By this means the grinding wheel may be balanced so as to run quietly at the highest speeds. This also is an important feature in the production of good work. Wheels up to 24 inches diameter and 4 inches face can be used on work up to the full capacity of the machine.

Besides driving the wheel spindle, the main driving shaft has also connections with the pump and with the feed and work spindle mechanism. The feed and speed connections are taken off from the pulley at the extreme right in Fig. 2, and at the left in Fig. 1, being belted to a gear box at the end of the machine in front. From this gear box a belt connection with the headstock, which is strongly geared, giving ample power for the largest piece of work that can be placed in the machine, is provided. It gives five rates of speed for each of the two positions of the back gear in the driving box, or ten rates of speed in all, indicated plainly on a dial. All the clutch mechanisms are of hardened tool steel, and all the gears have planed teeth.

For roll grinding, the machine is fitted with special supports for the necks or journals of the work. Previous to the operation of finishing the body of the roll, these journals or necks are themselves ground, with the roll carried on centers the same way as for regular plain grinding, but in grinding the roll face, the work is supported by its own bearings. The importance of having the roll face true and concentric with the journals is, of course, vital. This method of supporting the roll while finishing it has been found the only practical and reliable one for general use.

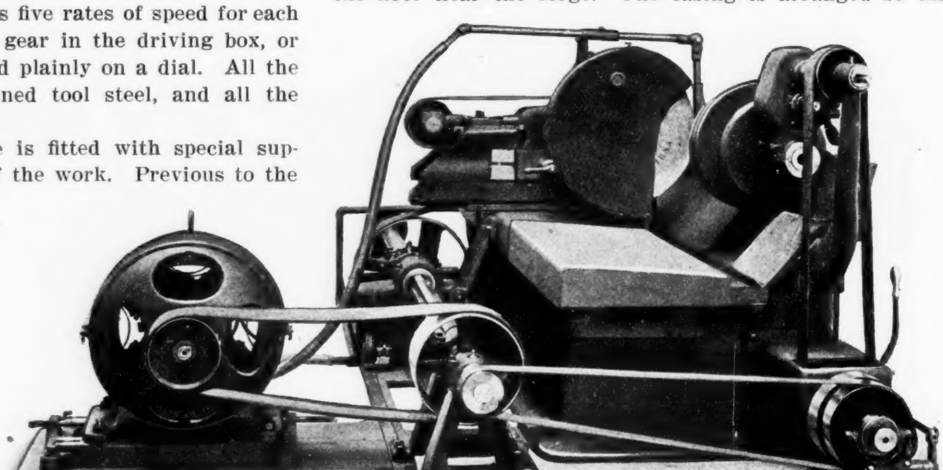


Fig. 4. End View of Gap Grinder, showing also Details of Self-contained Electric Drive

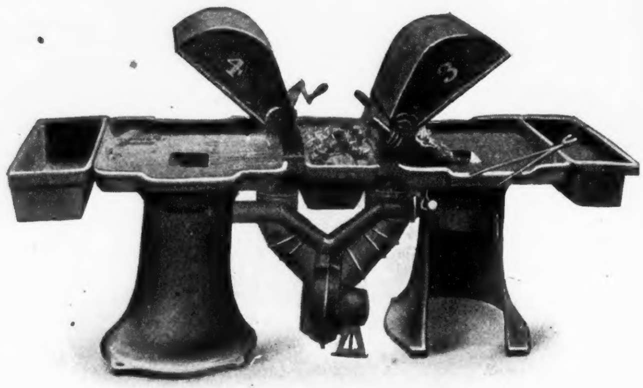
To compensate for any slight error in the alignment of the headstock and center line of the rolls, and to avoid any tendency of the drive to shift the roll from its true position parallel with the bearings, an equalizing fixture is adjusted to the face of the headstock. This drives the roll with equal force from opposite points. Neither the neck bearings nor the equalizing fixture are here shown.

As explained, this machine is also made in a form which is adapted more particularly for railroad work. For this work a gap in the bed is provided, as shown in Figs. 3 and 4. When the gap is provided, the grinder is adapted to handle locomotive pistons, piston valves, valve stems, cranks, links and knuckles, pins, axles, etc., it being possible to grind piston rods with the pistons in place and to swing valve yokes when grinding the stem. The gap can be located at the time the machine is being built in any desired position to suit special work.

STURTEVANT ELECTRIC FORGE BLOWER

The accompanying illustration shows a motor-driven forge blower made by the B. F. Sturtevant Co., Hyde Park, Mass., applied to a pair of Sturtevant forges. The blower is composed of a pressure fan of the multi-vane type, enclosed in a pressed steel plate casing, driven by a direct-connected electric motor, operating from the electric lighting circuit if necessary. The multi-vane type of fan wheel is highly efficient and gives a greater pressure and volume of air than can be obtained from fans of the ordinary type.

It may be of interest to mention that with this blower con-

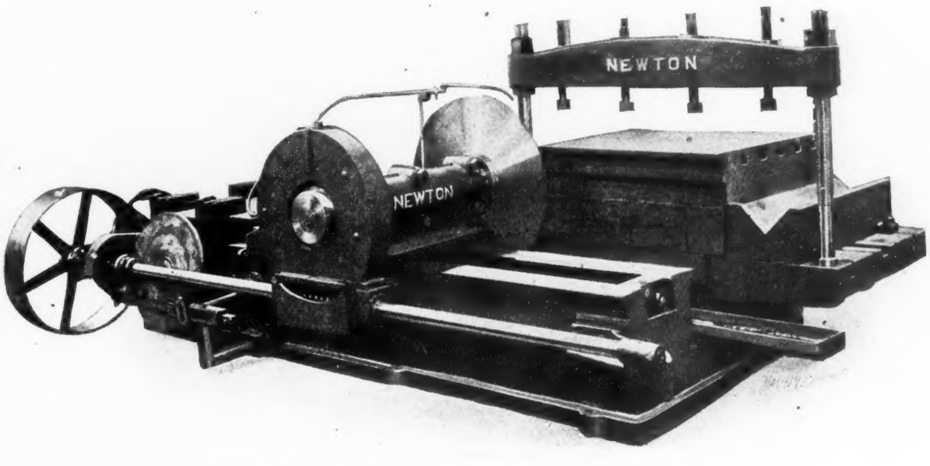


Motor-driven Forge Fan made by the B. F. Sturtevant Co., Hyde Park, Mass., applied to a Double Forge

nected to a forge with a tuyere area of 1.5 square inch, two-inch round soft steel stock may be heated to a welding heat in four minutes, and one-inch round soft steel stock in 2½ minutes. The blower can be set on a bench, shelf or box, or on the floor near the forge. The casing is arranged so that it can easily be revolved to discharge in any desired direction. The weight of the complete outfit is 35 pounds; the total height is 14½ inches, and the width from the inlet of the fan to the outside end of the motor-shaft 10 inches. The base is provided with four holes for screwing the blower to the floor or shelf. In addition to its use as a forge blower it will be found convenient for blow pipes, soldering tubes, etc.

NEWTON COLD SAW CUTTING-OFF MACHINE

A modification of the combination type of cold saw cutting-off machine manufactured by the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., is illustrated herewith. This machine is designed to give a maximum output on work comparatively short in length and of large diameter. The drive for the spindle is direct through a triple-threaded steel worm which is fitted with roller thrust bearings and a large wormwheel having a bronze ring. By having a worm of large diameter, the length of the stock that can be cut is limited, but the life of the gearing is prolonged and chatter at the saw reduced to a minimum. In this connection it might be mentioned that on all types of machines, the saddle feed screw has a bearing at each end permitting of its being always maintained in tension for the purpose of eliminating chatter.



Newton Cutting-off Machine with Powerful Direct Worm Drive

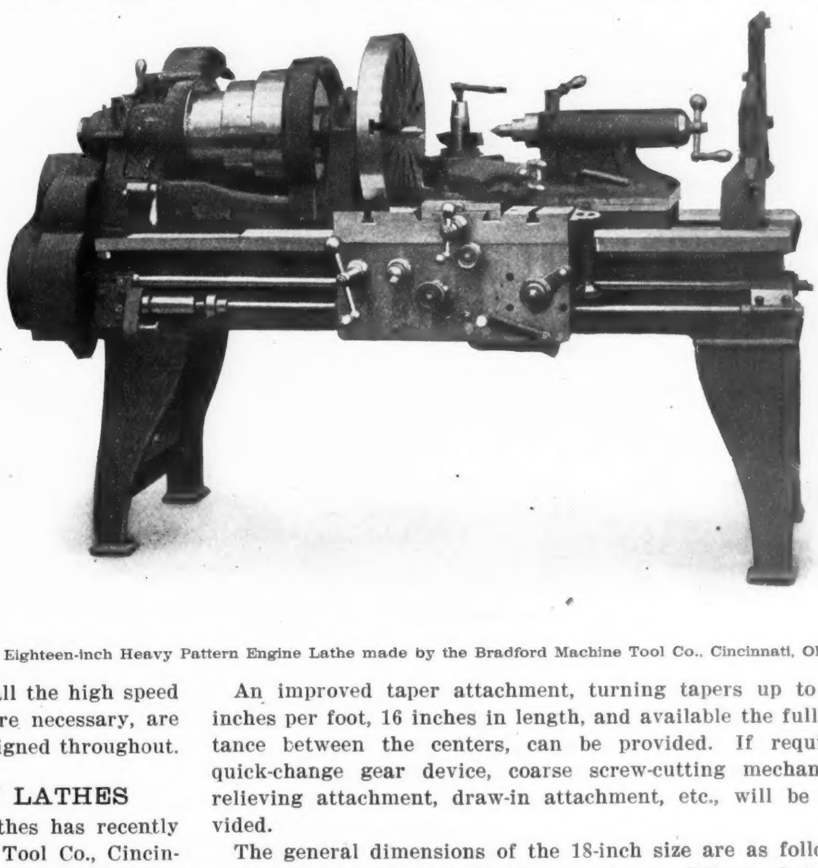
Both worm and wheel are encased, as shown, for continued lubrication. On this particular machine the spindle has a continuous capped bearing which is equal in length to the over-all diameter of the saw blade. The spindle saddle has a square locked gibbed bearing cast solid with the taper shoes to compensate for wear. The feed of the saddle is continuous and has a variation ranging from 1/4 to 1 1/2 inch per minute. An adjustable, automatic and positive safety release is provided and also a power quick return. As the motor is fitted with a double throw switch, the quick return is, of course, available in both directions.

This machine is furnished with a bottom table having an in-and-out adjustment for setting work to the required position for obtaining the desired length. In addition, there is furnished an auxiliary top table for handling flats or multiple pieces, and a V-block for holding angles or round stock. The clamping yoke just above the table is rigidly supported by two vertical screws to which are fitted nuts for obtaining the necessary vertical adjustment. Ordinarily, for clamping work it is desirable to operate the independent hand jacks. All the operating levers of this machine are located within convenient reach of the operator, and it is furnished with a pump, piping and attachments for cutter lubrication. All parts are of the very best material and all the high speed shaft bearings are bushed. The gears, where necessary, are made of steel, and the machine is rigidly designed throughout.

BRADFORD HEAVY PATTERN LATHES

A new design of heavy pattern engine lathes has recently been brought out by the Bradford Machine Tool Co., Cincinnati, Ohio. These machines are built in 18- and 22-inch sizes, the accompanying illustration showing what is known as the 18-inch heavy pattern Bradford standard lathe. In the design of these machines special efforts have been made to correctly distribute the metal in order to provide sufficient strength for the most severe duty. The machines are double back-geared, and are provided with a three-step cone pulley for a 3 1/2-inch belt on the 18-inch size, and for a 4-inch belt on the 22-inch size. The spindles are made of high carbon crucible steel, bored from the solid, ground and mounted in adjustable bronze bearings. The hole through the spindle in the 18-inch size is 1 11/16 inch, and in the 22-inch size is 2 inches. The spindles extend clear through the head so that draw bars and tubes for draw-in attachments can be conveniently used; the draw-in attachments can be furnished and attached to the lathe at any time.

The carriage has a full bearing on the V's for its entire length, and is gibbed in front and back and designed with an extra amount of metal in the cross bridge. The apron is of the double-plate pattern, with a non-interfering safety device, so that the feed-rod and the lead-screw cannot be engaged simultaneously. The lead-screw is cut from a master screw, and the nut is of the split pattern made of phosphor-bronze. A chasing dial is provided for catching the threads, so that threads can be cut without stopping the lathe or reversing the lead-screw. The range of threads that can be cut on either of the sizes of lathes is from 2 to 40 per inch including 11 1/2 threads. The feeds cover a range of from 8 to 90 per inch for the 18-inch size, and from 5.7 to 64 per inch for the 22-inch size. The feed gear train is at all times independent of the screw cutting train, which provides for a simple and direct drive for each. The idea of using a separate train of gears for feed purposes will appeal to all mechanics as a feature of great merit. The lathe is provided with a friction cross-feed graduated to read in thousandths of an inch, and with a friction traverse feed in the apron, and automatic stop for the carriage.



Eighteen-inch Heavy Pattern Engine Lathe made by the Bradford Machine Tool Co., Cincinnati, Ohio

An improved taper attachment, turning tapers up to 4 1/2 inches per foot, 16 inches in length, and available the full distance between the centers, can be provided. If required, quick-change gear device, coarse screw-cutting mechanism, relieving attachment, draw-in attachment, etc., will be provided.

The general dimensions of the 18-inch size are as follows: Swing over ways 20 1/4 inches; maximum distance between centers of six-foot lathe, 2 feet 2 1/2 inches; back-gear ratios

10.95 to 1, and 3.31 to 1; spindle speed range, 12 to 349 revolutions per minute; weight of lathe with six-foot bed, 2950 pounds; and weight of bed per additional foot, 140 pounds.

The 22-inch size swings 22½ inches over the ways and takes 3 feet 7½ inches between the centers on an 8-foot bed. The spindle speed range is from 11 to 346 revolutions per minute; the back-gear ratios are 10.04 to 1 and 2.82 to 1. The weight of a lathe with 8-foot bed is 4400 pounds, and the weight of the bed per additional foot, 175 pounds.

A noteworthy feature is the complete manner in which all gearing has been covered. Not only does this provide for added safety in operating the machine, but the gear guards have been designed so that they give to the machine a finished and pleasing appearance, as well.

WOOD TILTED-TURRET SCREW MACHINE

A tilted-turret type of screw machine, with a friction geared head and geared automatic feed for the turret slide, has recently been brought out by the Wood Turret Machine Co., Brazil, Ind. This machine embodies in its design many improvements and new features which adapt it to the rapid and accurate production of duplicate parts.

It will be noted, by referring to the engraving Fig. 1, that the head and lower half of the gear guards are cast integrally, thus assuring great strength and rigidity. In addition to the friction geared head, a three-step cone of large diameter and wide face is provided, giving a powerful drive to the machine. Two spindle speeds for each speed of the cone are obtained by the friction geared head, thus enabling the operator to use two speeds without stopping the machine to throw in the back-gears. By moving the handle shown at the side of the cone to the right or left, the back-gears are thrown in or out while the machine is in motion, thus securing the necessary speeds for changing from boring to tapping, or for turning different diameters on the same piece, without stopping the machine.

The headstock end of the machine with the protective casing removed, is shown in Fig. 2. This view shows clearly the arrangement and construction of the friction geared head, and also the chain drive for the geared automatic feed to the turret slide. As will be noted, there is a sprocket screwed to the spindle of the machine which transmits the motion through a roller-chain to a shaft located in the bed. This shaft extends to the rear of the bed and transmits the feed motion to the gear-box of the turret slide. The details of the geared automatic feed are shown in Figs. 3 and 4. The necessary reduction in the speed of shaft *A* (which is the one that is connected by chain to the spindle) is obtained by means of four gears *B*, *C*, *D* and *E*. Gear *B* is keyed to shaft *A*, while gear *C* and the three gears adjacent to it, are solid and run free on their shaft. Gears *D* and *E* are also solid and are free to turn on their shaft. The power is therefore transmitted from *B* to *D* and from *E* back to *C*. The pull-pin *F* operates a sliding key which engages any one of the three gears mounted on the shaft with *D* and *E*. As these gears are always in mesh with the three which are adjacent to gear *C*, three different rates of feed may be obtained.

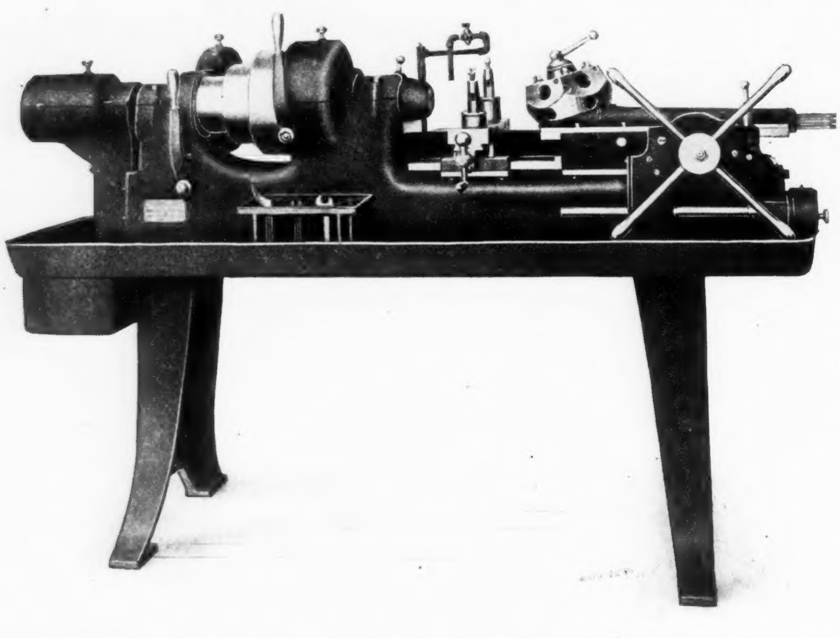


Fig. 1. Wood Tilted-turret Screw Machine with Friction Geared Head and Geared Automatic Feed to the Turret Slide

By referring to Fig. 4, the position of the gears which are interchanged to double up the number of feeds, making six in all, may be seen. This view also shows the automatic trip mechanism for disengaging the feed. This trip operates in conjunction with independent adjustable stops for each hole of the turret. The feed is transmitted from the spur gear on the pull-pin shaft *F* through two gears and the shaft *G* to the gears *H* and *I*. These latter gears are so arranged that they can be instantly interchanged, as stated, thus doubling the number of available feeds. On the same shaft with gear *I*, there is a worm meshing with a worm gear. This worm is held in a rocker arm, which throws it in and out of mesh with the worm gear by the operation of the hand lever. The worm gear is keyed to the same shaft that carries the turnstile. The turnstile shaft has mounted on its other end a spur pinion meshing with a rack secured to the under side of the turret slide, resulting in the automatic movement of the turret slide. The small forked lever *J* passes up through the under side of the turret saddle, and automatically trips out or disengages the feed in connection with the independent adjustable stops for each hole of the turret.

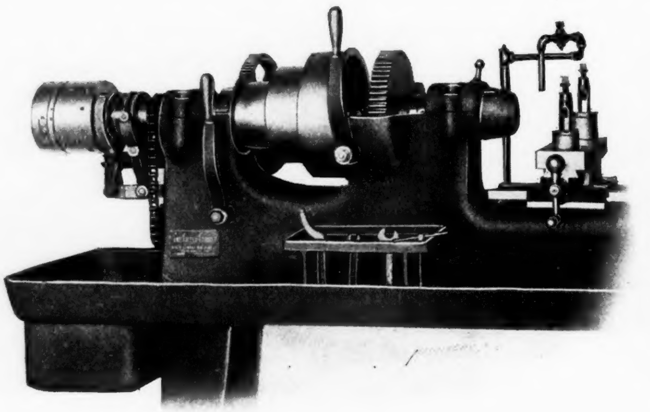


Fig. 2 View of Headstock End showing Construction of Friction Geared Head

Among the special advantages of this machine might be mentioned the tilting of the turret which makes possible the use of extra large box tools and die-heads on this machine. When the turret is swung around to the rear position, the tools are thrown up at an angle of approximately 30 degrees, entirely clear of the turret slide. The tilt of the turret also minimizes the strain on the center-bolt of the turret head, and applies part of the thrust directly to the inclined surface of the slide. This feature also causes a full bearing on the slide, and eliminates the tipping which is likely to occur with the high turret. Stock may be passed into or directly through the tilted turret, since the center-bolt has a hole directly through it; this feature allows the use of a short, stiff box tool and eliminates the necessity of the box tool rest guide. Thus with this machine it is possible to obtain the benefit of the long effective motion to the slide. The turret also being hexagonal allows the box tool to be bolted to the face, leaving the turret hole open to let the work pass through. Work, when machined, is passed into or directly through the turret, coming out at the rear through one of the auxiliary holes in the lower half of the turret without interfering with a tool in the rear position.

In regard to the general construction it may be mentioned that the machine is equipped with bar feed for automatically

feeding stock through the spindle. There are four gears and a scroll which gives the power to two rollers, while a second scroll is used to fit the adjusting jaws to the stock. Provision is made on the stock adjusting jaws to take round, square, hexagon, or any other shaped stock that one may desire to use. The same lever (located on the left-hand end of the machine) which operates the automatic bar, operates the automatic chuck, opening it before the feed is thrown into action when the lever is thrown to the left, and closing it after stopping when the lever is thrown to the right. Thus one lever controls two operations, and at the same time eliminates

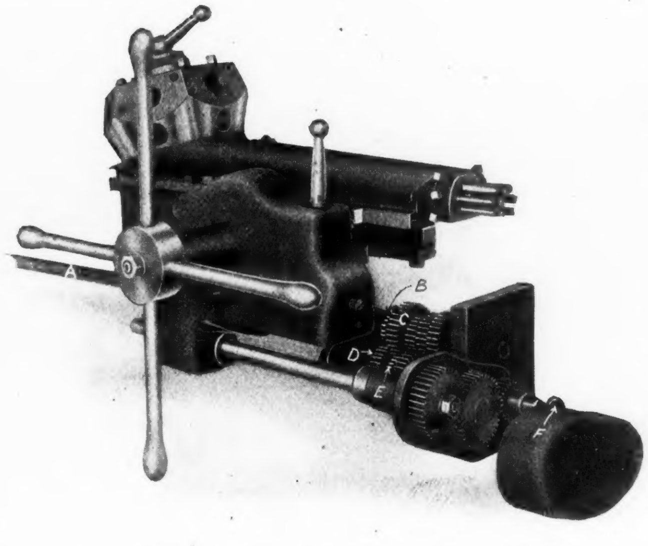


Fig. 3. Detail View of the Geared Automatic Turret Feed

the danger of trying to roll stock into the machine when it is gripped by the collet.

The turret slide, which rests and moves in the saddle, is furnished with a taper gib fitted the whole length of the saddle on either side, providing a means of adjusting the slide sideways. The saddle is gibbed to the outer edges of the bed by flat gibs throughout its entire length. There is a supplementary taper base to the saddle by means of which the turret holes can be adjusted to the exact height of the center of

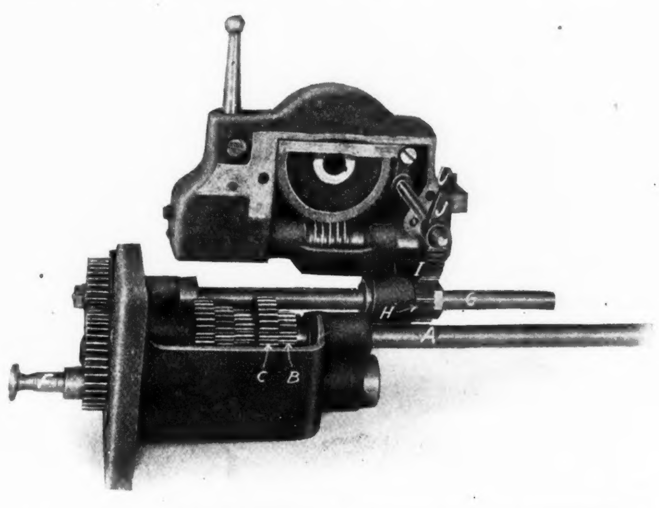


Fig. 4 Another View of Turret Feed Mechanism showing Automatic Trip

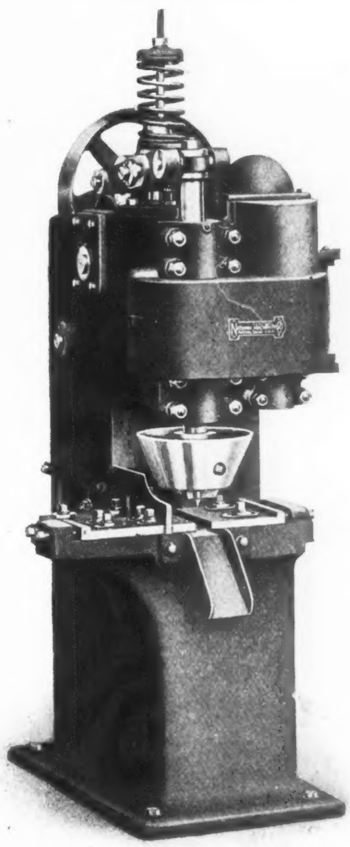
the spindle. This provision makes it unnecessary to rebore the turret holes. Automatic stops for each hole in the turret are furnished with the machine and are instantly adjustable to different lengths.

Hill, Clarke & Co., Inc., of Boston and Chicago, are the sales agents for this machine. This firm also has branch offices at New York, Philadelphia and Cleveland.

NATIONAL NUT BURRING OR SHAVING MACHINE

The accompanying illustration shows a new design of nut burring or shaving machine for hot pressed nuts, recently brought out by the National Machinery Co., Tiffin, Ohio, manufacturer of bolt, nut and rivet machinery. The machine is of the semi-automatic type, of simple design, its specific features being high productive capacity accompanied by perfect safety to the operator.

The machine will easily handle the output of a hot pressed nut machine, and a production of from two to four times that of the ordinary hand-feed burring machine is possible. When in operation, it is only necessary for the operator to place the nuts in a slot at the side of the machine and move them forward. The raising and lowering of the burring spindle, and the feeding of the nuts under the revolving cutter is entirely automatic. This, it will be seen, insures a maximum production, as the machine sets the pace for the operator. At the same time it eliminates all chance of accident to the operator incident to the feeding of the nuts under the rapidly revolving cutter, as this feature is eliminated and taken care of by the automatic feed. The finished nuts are ejected from the machine automatically, passing through a chute shown in the illustration in the front of the machine.



Nut Burring Machine, made by the National Machinery Co., Tiffin, Ohio

The finish on the nuts is uniform. All burr is effectually removed, and as the cutters are lowered gradually by a cam movement, there is no tendency of the burr to turn over the edge instead of being cut off. A compensating spring is provided which takes care of variations in nut thicknesses, and safety arrangements are provided both on the burring spindle and feed mechanism to prevent breakage. Changes for various sized nuts can quickly be made. The machine is built in two sizes, the capacities being $1\frac{1}{4}$ and 2 inches, respectively.

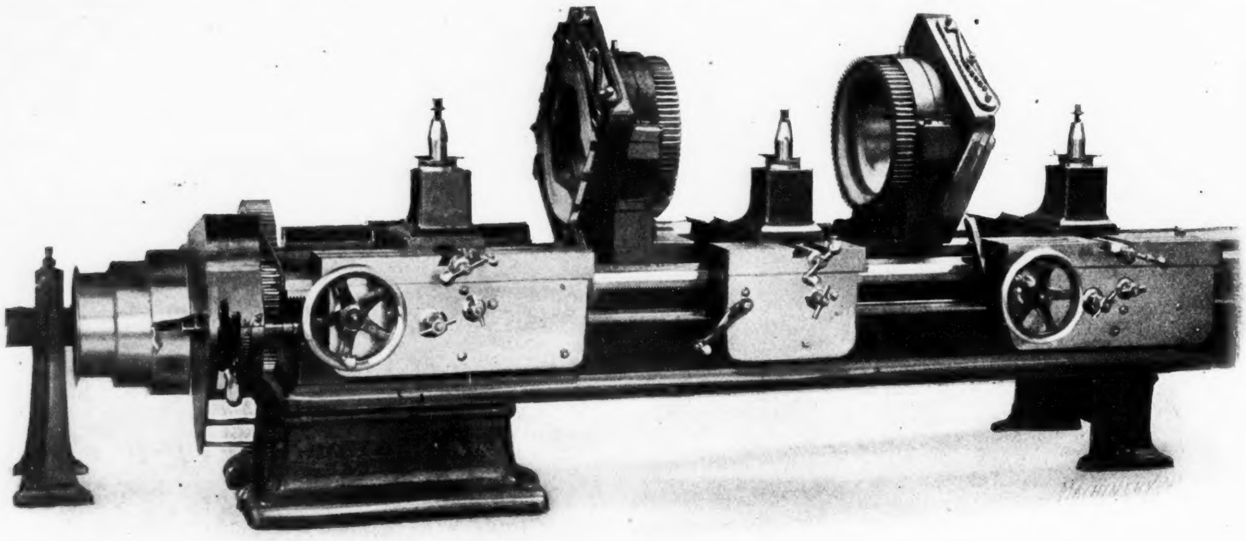
FAY & SCOTT DOUBLE-END TURNING AND FACING LATHE

A double-end turning and facing lathe, which was designed and built by Fay & Scott, Dexter, Me., for the Merrimac Iron Foundry Co., of Lawrence, Mass., is illustrated herewith. This lathe is specially built for facing the ends and turning the flanges of heavy cast iron columns. The work is gripped on the outside by two large hollow chucks, which are mounted in massive bearings or brackets. These brackets may, of course, be adjusted along the bed to accommodate columns of different lengths. The machine will handle a maximum length of $22\frac{1}{2}$ feet, while the chucks will take a maximum diameter of 13 inches. Flanges as large as 32 inches in diameter will swing over the lathe carriages.

As the engraving shows, this machine is equipped with three carriages. Those at the ends make it possible to perform the turning and facing operations on the flanges of columns simultaneously, thus greatly facilitating work of this kind. The carriage in the center may also be used when necessary on special work thus making the tool more universal. The two

end carriages both have power, longitudinal and cross feeds, while the middle carriage has a power cross feed only.

The drive is by belt onto a four-step cone pulley, which is supported by an outboard bearing as shown. The power is transmitted from this pulley through gears to a splined shaft which runs through the center of the bed. This shaft, in turn, is connected to the chucks or work holders through gearing, the arrangement of which is as follows: On the splined shaft and just beneath each chuck is mounted a sliding pinion



Double-end Turning and Facing Lathe built by Fay & Scott

which drives through an intermediate gear to the hollow gear which forms a part of the chuck. One of these intermediate gears is shown in the engraving in mesh with the right-hand chuck gear. These chucks are equipped with hardened cast steel, V-shaped jaws, which are operated by two right- and left-hand threaded screws. These screws, by means of a connect-

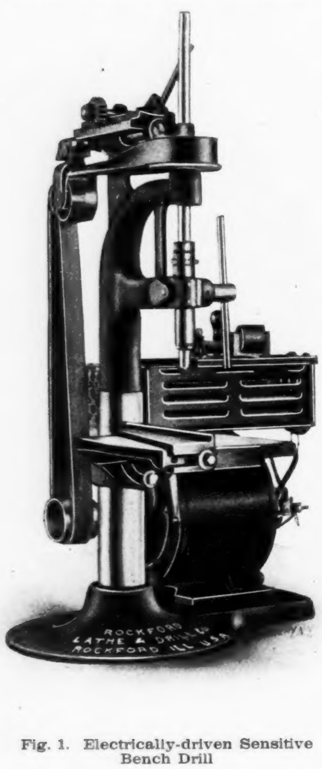


Fig. 1. Electrically-driven Sensitive Bench Drill

Fig. 2. Two-spindle Bench Drill with Self-contained Countershaft

ing chain, are turned simultaneously. The chains, as well as the sprockets on which they run, are plainly shown in the engraving. This arrangement makes it possible to obtain a powerful grip on the work, which will withstand the heaviest cutting strains.

The changes of carriage feed are obtained by means of a quick-change sliding tumbler gear at the head end of the lathe. As the engraving shows, the bed of the machine is deep in section, and all parts are heavily built to withstand the strains incident to the class of work which the lathe is designed to handle. The weight of this machine, with a 26-foot bed, is 12,000 pounds.

ROCKFORD SENSITIVE BENCH DRILLS

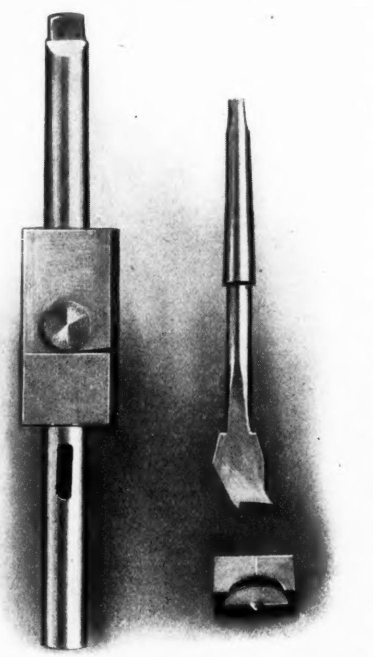
The sensitive bench drills illustrated in Figs. 1 and 2, are the product of the Rockford Lathe & Drill Co., Rockford, Ill. These machines, while designed along the same lines as the Rockford tools previously illustrated and described, contain one or two important changes in their construction. The machine shown in Fig. 1 is of the 10-inch size and is electrically driven. The motor and speed controller are mounted on an extension cast to the base. The motor can be furnished with either direct or alternating current, and by means of the controller a wide range in speed can be obtained. The driving belt passes from the pulley on the armature shaft over two idlers at the rear which are mounted on an adjustable bracket actuated by the rack and pinion movement shown at the top of the column. This arrangement provides a very quick means of giving the belt the necessary tension. The spindle is counterbalanced by means of a taper plunger that fits in the spline of the quill. The necessary thrust on the spindle is obtained by an adjusting screw which acts on a spring back of the plunger. A stop collar is placed on the outside of the quill above its bearing, as shown, which gives a positive stop and makes it possible to drill different holes to the same depth with accuracy. The machine is equipped with a tilting table which adapts it to drilling holes at an angle and for other irregular work. The size of the table is 8 by 8 inches and its vertical adjustment, 9 inches. The maximum distance from the spindle to the table is 12 inches, and the spindle has a lever feed or 3 inches.

The machine illustrated in Fig. 2 is of the same size as the one just described, but of the two-spindle type. As the illustration shows, this drill is arranged with a self-contained countershaft which is mounted on brackets attached to the base. It will also be noted that two-step cones are mounted on this countershaft to give the necessary speed variations.

When the belt is to be shifted from one step to the other, the cone is moved over to a stop where a ball plunger engages a hole in the shaft. The belt-tightening arrangement is the same as the one previously referred to, and is especially useful on this particular tool for quickly taking up the slack in the belt when the latter has been adjusted to the smallest cone step. The spindles are also equipped with a spring-actuated counterbalancing device and the tables are of the tilting type. The size of these tables, their vertical adjustment and the maximum distance to the spindle is the same as given for the single-spindle machine.

THE PHILLIPS BABBITT METAL LOCK DRILL

The accompanying illustration shows an interesting tool used for boring undercut holes in bearing boxes, or other surfaces to be lined with babbitt metal, for locking the metal securely and permanently in place. The tool is the invention of Mr. C. H. Phillips, 689 Massachusetts Ave., Cambridge, Mass. Before this drill is used, the hole is first started by using a twist drill ground to an angle of 72 degrees, and a hole is drilled to a depth of 3-16 inch. After that the drill shown to the right in the illustration is used, it being held in the special jointed socket shown to the left. This socket permits the drill to wabble so as to cut or bore a hole having a dovetail section as shown in the view at the bottom of the drill, the point of the drill being guided by the hole already drilled as mentioned. These drills cannot be used in an ordinary drill chuck. They are made in ½, ⅝ and ¾-inch standard sizes, and special sizes can be made if required. High-speed steel drills of this type will bore a hole in a fraction of a minute. Among other uses, it may be mentioned that the tool is very convenient for providing locking means for the babbitt on the shoes on crossheads of stationary and marine engines, and for thrust bearings on marine engines, as well as for securing the babbitt in locomotive bearings.



The Phillips Babbitt Metal Lock Drill, with Special Socket and Section of Hole Bored

BAIRD LARGE OBLIQUE TILTING TUMBLER

The accompanying illustration shows a large size oblique tilting tumbler brought out by the Baird Machine Co., Oakville, Conn. This tumbler is larger than those previously brought out by the same company, and is known as the No. 3 size. It is especially intended to meet the demand for a machine to tumble castings of medium size and weight, such as valves, stove trimmings, the larger sizes of chain, etc. The capacity of the tumbling barrel is about four bushels or 700 pounds of work. Tumbling barrels of from 28 to 48 inches diameter at the base can be mounted interchangeably in the machine, the barrels being made either of wood, cast iron, sheet steel or brass.

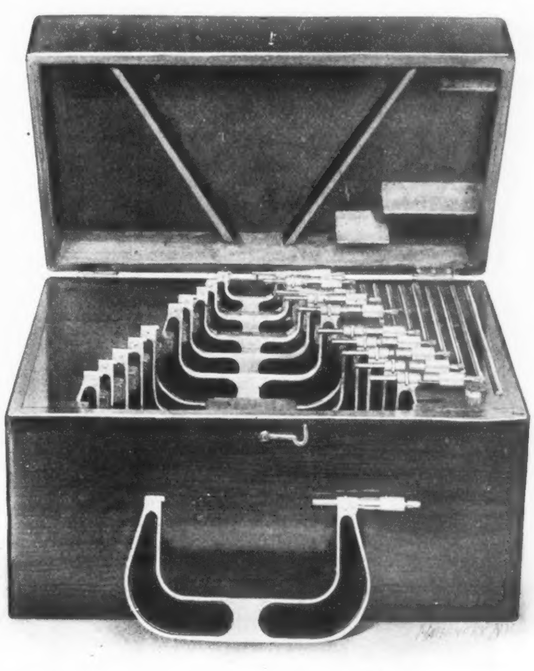
The No. 3 Baird tumbler has all the advantages of the regular line of oblique tilting tumblers built by this company, including convenient means for putting in the work, inspecting articles during the progress of operation, tilting, elevating or dumping the contents, which all can be accomplished without stopping the machine. In addition to the mechanism required for these operations, the No. 3 tumbler is fitted with a clutch pulley controlled by a lever placed conveniently for the operator, near the tilting crank. The tilting mechanism is well back-geared, and makes the operation of the barrel comparatively easy. The weight of the machine without barrel is 2000 pounds.

Large Size Tumbler made by the Baird Machine Co., Oakville, Conn.

NEW LINE OF BROWN & SHARPE MICROMETER CALIPERS

The accompanying illustration shows a complete set of a new line of micrometer calipers recently brought out by the Brown & Sharpe Mfg. Co. of Providence, R. I. The complete set comprises eleven micrometers ranging from 1 inch to 12 inches, and from 25 to 300 millimeters. These micrometers are intended for shops where accurate measurements must be taken on large work, and are made heavier than those of earlier designs. The frame of the micrometer is made of I-section, which provides great strength and rigidity, while at the same time the weight of the instrument is reduced to a minimum so as to make it convenient to handle.

Care is exercised in making to have the micrometers very accurate when they leave the makers, and every precaution is taken to have them retain their accuracy after they have been in use for some time. The measuring surfaces are made perfectly square, so that small projections on a plane surface for example, may be measured with accuracy. A standard gage is furnished with each micrometer for testing purposes



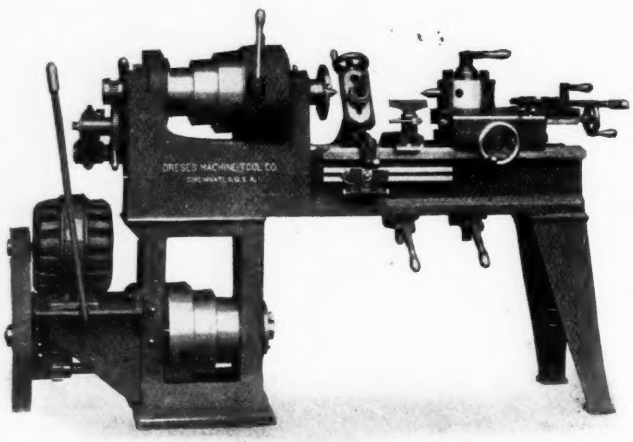
Set of Improved Micrometers made by the Brown & Sharpe Mfg. Co., Providence, R. I.

and means for adjustment to compensate for wear are provided. All points that are exposed to wear are hardened. These micrometers are furnished either singly or in sets of six or eleven, the set of six comprising the six largest sizes, with an inclusive capacity of from 6 to 12 inches.

DRESES ELECTRICALLY-DRIVEN 16-INCH UNIVERSAL MONITOR LATHE

Because of the high speed at which a brass lathe must run, it has been found impracticable to have a geared connection between the motor and spindle. It is also undesirable to mount the motor on top of the headstock as disturbing vibrations are likely to result. To overcome these objectionable features, the Dreses Machine Tool Co., of Cincinnati, Ohio, has equipped its brass lathes with a special form of motor drive. This drive, as applied to a 16-inch universal monitor lathe, is shown in the accompanying illustration. The motor-driven turret lathe described in the March, 1909, number was also equipped with this form of drive.

As the illustration shows, the countershaft with its cone is placed in the cabinet support under the head. The motor, which is mounted on a bracket, has a rawhide pinion on its



Dreses 16-inch Universal Monitor Lathe with Special Motor Drive

armature shaft, which meshes with a large gear on the lower cone shaft. As an electrically controlled device would be somewhat slow for brass and similar work, a frictional mechanical connection between the motor and countershaft is used. The long vertical lever shown operates this device and starts, stops or reverses the countershaft instantly without stopping the motor. It will be noticed that the cone pulley is placed as low as possible to obtain the maximum length of belt and to avoid vibration. The motor used is of the constant-speed, polyphase type and develops, in this particular installation, 2½ horsepower. When a variable speed motor is to be used, single pulleys are substituted for the cone pulleys. This drive arrangement is used on all the screw machines, turret and brass lathes manufactured by this company.

BROWN & SHARPE NEW TYPE FACE MILLING CUTTER

A new type of inserted tooth face milling cutter has recently been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I. This cutter, as illustrated in the accompanying halftone and line engraving, Figs. 1 and 2, embodies some important changes from the ordinary type of inserted blade milling cutters, and presents a radical departure from the usual construction. The two main features of the cutter are the means provided for using the same cutter on different size spindles on different machines, this being accomplished by the employment of special sleeves, and the provision for a quick release from the nose of the spindle when the work is finished and the cutter is to be removed.

The cutter consists of four parts, as shown in Fig. 1: the cutter proper, the split sleeve shown to the left, the clamping plate shown to the right, and the drawing-in bolt. As shown in Fig. 2, the sleeve is screwed onto the spindle nose and the outside of the sleeve is provided with a taper fitting the hole of the cutter body. This taper is sufficient to cause the latter to release readily from the sleeve when not forced inward by the clamping plate. When in use, however, the cutter body is drawn onto the sleeve by the clamping plate by means of the drawing-in bolt as shown, and is keyed to the sleeve as indicated, as an extra precaution against turning or slipping. When the drawing-in bolt is tightened, the sleeve is contracted

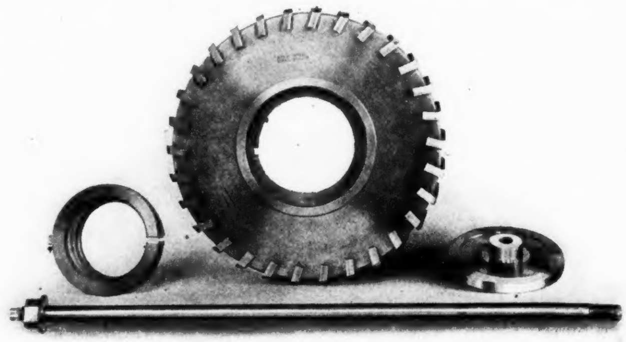


Fig. 1. New Type Brown & Sharpe Inserted Blade Milling Cutter, with Sleeve, Clamping Plate and Drawing-in Bolt

and closely grips the spindle, thus furnishing the full efficiency of the drive to the cutter at all times. The cutter can be quickly and easily removed simply by loosening the drawing-in bolt. As the cutter is made without a hub, it is held close to the spindle end and thus provides for the maximum of working space.

When it is desired to use the same cutter on several machines having different sizes of spindles, all that is necessary is to provide a sleeve for each size of spindle. The outside of these sleeves all fit the hole in the cutter body, while the holes in the sleeves, of course, are made to fit the spindles of the various machines.

The features of the new tool will be readily appreciated both by machine shop owners and machine operators. To the former the possibility of avoiding keeping a large number of cutters on hand, differing only as to the size of hole to fit different spindle noses, will appeal; to the latter the avoidance

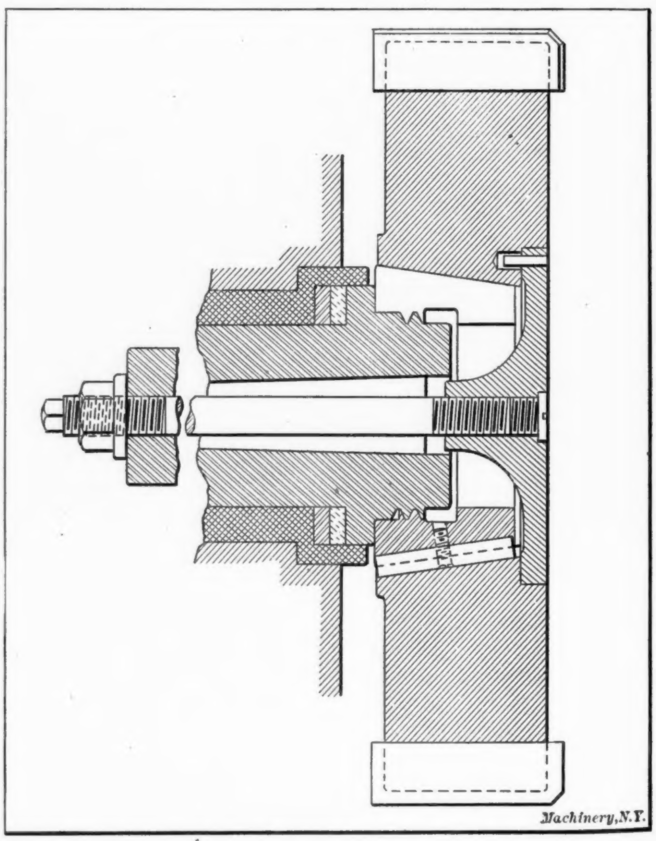


Fig. 2. Section through Milling Cutter Mounted in Place on Spindle Nose

of trouble oftentimes experienced in removing large cutters from the spindle nose after having taken heavy cuts will be of especial interest.

DAVENPORT CLOCK AND WATCH PINION MACHINERY

In Fig. 2 is shown a pinion and staff of the kind ordinarily used in clocks of various sizes and designs. It consists, as may be seen, of a shaft or "staff" on which are pressed three brass disks or "collets." In the two at the right are inserted wires or "needles" as they are called, forming a "lantern" pinion. The disk at the left is turned and shouldered to form a seat for the brass gear wheel, which is afterward pressed on it and staked in place.

Until very recently the thousands of these pinion shafts made every day, had been made in accordance with practices which were fifty years old or more. The first operation consisted in cutting the wire for the staff in lengths a little longer than the finished staff, pointing one end at the same time. This was done in an automatic straightening, cutting-off and pointing machine, and was the only automatic work in the making of the pinion. The brass disks or collets were then driven on in a sort of small arbor press, in which the wires were placed by one boy and the disks by another, and the wire driven through them.

The turning was done by a man in what was called a "clock lathe." This consisted practically of a speed lathe having a live spindle with a draw-in chuck, operated by the knee of the workman. The footstock was of the common type, and the turning was done by tools held in a long bar sliding in adjustable V-blocks on the head- or foot-stock. There were usually four tools in this bar, one on each of the four sides, for turning the different parts of the pinion. Each tool was set out to turn the desired diameter, and stops were provided for each tool, thus duplicating the lengths of the cuts. The pivots were finished by a highly polished steel burnisher, dipped in a soap solution, which was dexterously applied while the pivots were revolving at a high speed. An expert turner could finish from 700 to 1000 pinions in a day of ten hours.

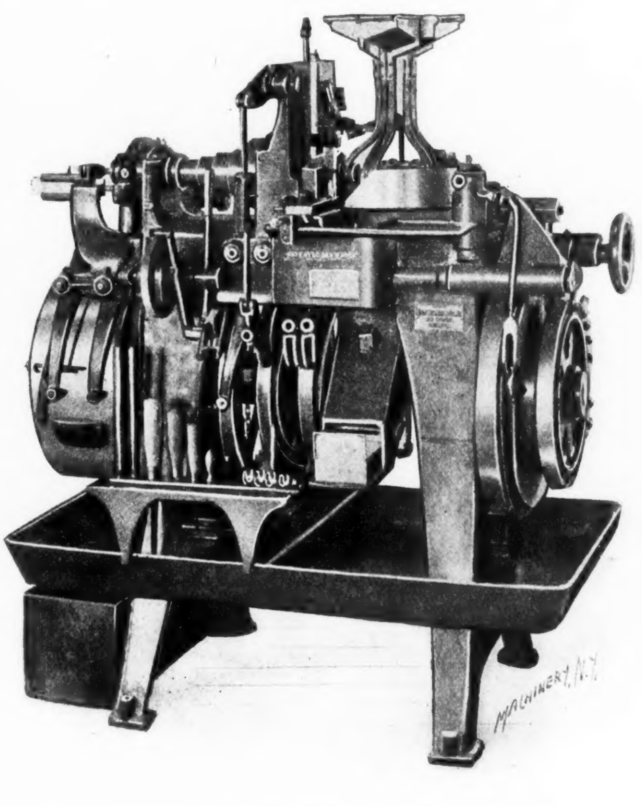


Fig. 1. Davenport Automatic Machine for Assembling and Turning "Lantern" Pinions

The holes in the collets for the needles of the lantern pinions were drilled by girls in a special jig of simple construction. These girls became very expert, pulling the lever which fed the drill with one hand, and indexing the head which held the pinion with the other. Afterward the needles were inserted and the holes staked over to keep the needles in place.

This method of making lantern pinions had been in vogue for so long that it was thought impracticable to perform the operations automatically. That this was not impossible, however, is shown by the line of machines which we herewith illustrate and describe. These consist of a staff turning machine for finishing the staff and pressing on the brass collets, and a lantern pinion drilling machine for automatically in-

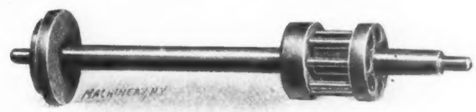


Fig. 2. A Completed Lantern Pinion as used in Clock Work

dexing the pinions and drilling the holes through the needles. These machines are the design of Mr. W. S. Davenport, and are built by the Davenport Machine Tool Co., New Bedford,

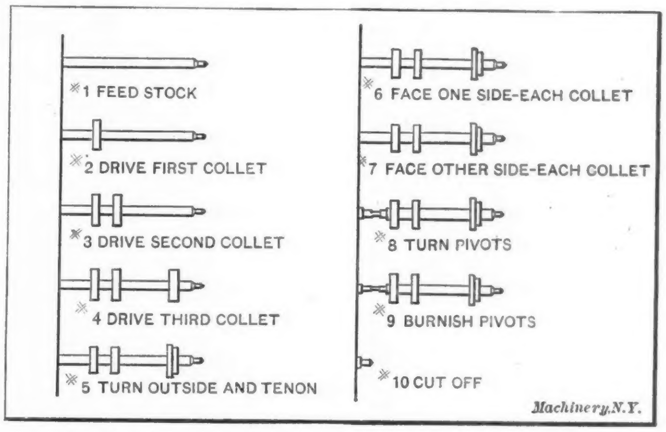


Fig. 3. Order of Operations followed in Machine shown in Fig. 1

Mass. In addition to these we show a universal automatic staff lathe for small clock pinions, which will be described later.

Lantern Pinion Turning Machine

The first machine, shown in Fig. 1, is the automatic turning machine. This performs the operations of finishing the staff over all, pressing on the collets, turning, facing and shouldering them, and delivering the whole completely assembled ready for drilling the needle holes. The machine is similar in many ways to the automatic screw machine of the "Hartford" type, but, in addition to the regular turret, it has another with its axis parallel with the spindle and sliding vertically above it. This turret carries five tools, making seven cross-slide tools available, as is required for finishing the pinions.

The first operation is feeding the stock out to a stop. The pivot on the front end of this stock has already been formed and burnished, as shown in Fig. 3. In the second, third and fourth operations, the collets are driven. These collets are placed loosely in the aluminum hoppers seen above the regular turret in Fig. 1, and by the motion of this turret they are shaken so as to come down an incline, and then to slide down the vertical chute into line with the spindle. Here they are in position to be driven on the wire held in the spindle, which is to form the shaft of the pinion, the spindle being stopped at the time. When two collets are of the same size, as is the case with the first two driven on in Fig. 3, they are both driven from the same magazine, the second magazine driving the third collet.

For the sixth operation the spindle is started and a swinging box-tool held in the regular turret turns off the outside diameters of the collets, and also turns the tenon of the larger collet where it is driven on. The tool-holder with three facing tools then comes down in the vertical turret, and faces one side of each of the three collets for the seventh operation. This vertical turret is again revolved and another holder comes down, facing the other sides of the same collets.

The pivots are now formed (eighth operation) by the regular cross-slide tools, one roughing and beveling the shoulder and the other finishing to size. The pivots are then burnished and polished by a pair of rollers in the vertical turret, in the

ninth operation. These rollers are hardened and highly polished, producing the same kind of a surface on the pivots themselves; they are rigidly held the right distance apart to burnish to the correct size for the pinion being made. Another tool in the vertical turret then necks both, and the last tool cuts off the pinion, for the tenth operation.

The machine will make from 1000 to 1800 complete pinions

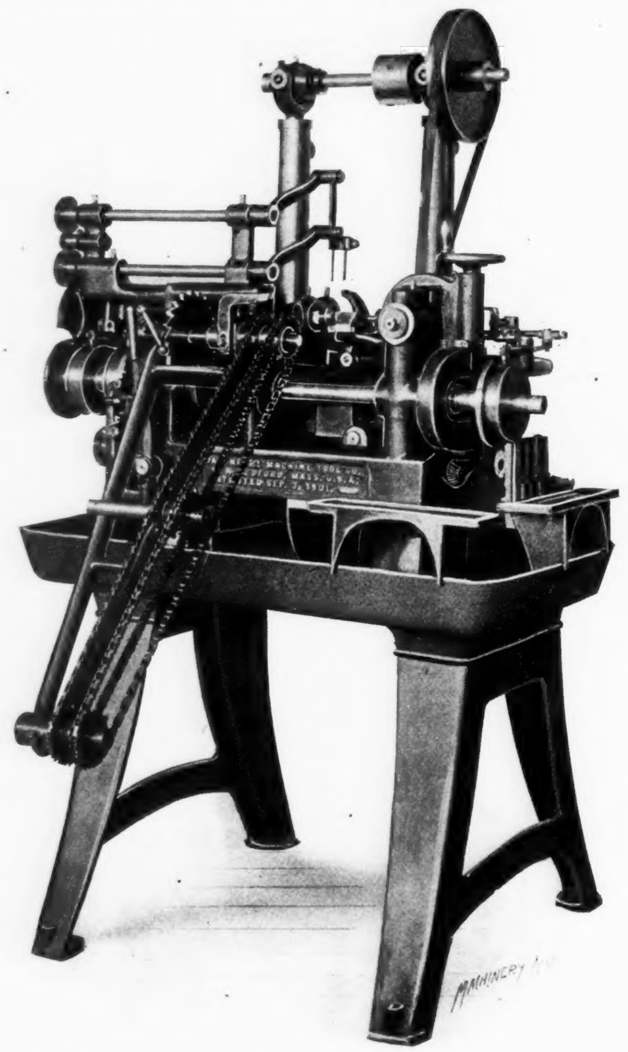


Fig. 4. Automatic Machine for Drilling Needle Holes for Lantern Pinions

in a day of ten hours, depending on the size, number of collets, etc. One operator usually runs four machines, making the cost of the pinions so much less than by the old methods described, that the machine commonly pays for itself in about a year's use. The work is more accurate than by the old method, the pivots being finished to within 0.0005 inch above or below the standard size, with the length of the pinion correct to within about 0.002 inch limit above or below.

In this machine the spindle speeds vary from 3600 to 1200 revolutions per minute, being suitable for wire from 0.075 inch diameter, used for alarm clocks, to 1/4 inch or greater diameter, used in ratchets, etc. Drilling attachments are sometimes placed in the cross-slide and are used for drilling holes through the shafts of ratchets for attaching springs and other parts. The hole through the spindle is 13/32 inch and the largest chuck used is for 3/8 inch stock. It feeds stock four inches long, and turns to two inches length. By making certain changes in the construction, however, it can be made to take cuts three inches long.

Many other kinds of work can be made in this machine besides clock pinions. Among these may be included the center pinions of steam and other pressure gages, pinions for mechanical toys, or other work requiring an unusual number of forming tools or requiring to be burnished. This operation of burnishing makes the best finish known for a staff bearing, being far superior to grinding or any other process.

It may be interesting to state that from the time the first lines were put on paper for this machine until the machine was turning out satisfactory work, was only about five months, which is an unusually good record in automatic machinery building.

Lantern Pinion Drilling Machine

The companion machine which performs the operation of drilling the small holes in the double collets for inserting the needles, is shown in Fig. 4. This has a magazine in the shape of a chain, with side plates having notches in which the pivots of the pinions are placed. The magazine shown holds about 50 pinions; they are taken from the chain by a pair of fingers mounted on the double arms seen about the spindle in the illustration. These place the pinion in line with the work-holding spindle, which then grasps it, the foot center coming up at the same time and holding and centering the outer end.

The spindle is now brought up and, under the action of suitable cams, the drill is fed slowly through the first collet, quickly through the space between the two, and again slowly nearly through the second one. It is then quickly withdrawn, the spindle holding the pinion is quickly indexed, and the drilling is repeated. The machine drills a hole in a second in both disks, or 60 holes a minute, besides feeding the pinions into the spindle, ejecting them, etc. The drill is often as small as 1/32 inch in diameter, and as the hole in each disk is about 1/16 inch long, it will be seen that the drill feeds through about 7½ inches per minute, making allowances for various stoppages during a day of ten hours. This amounts to about 300 feet, which is certainly a long hole for a 1/32-inch drill to make in a day. As one operator can feed four or five machines, the operation is performed at a very low cost. The drills are held in regular watchmakers' chucks, and run

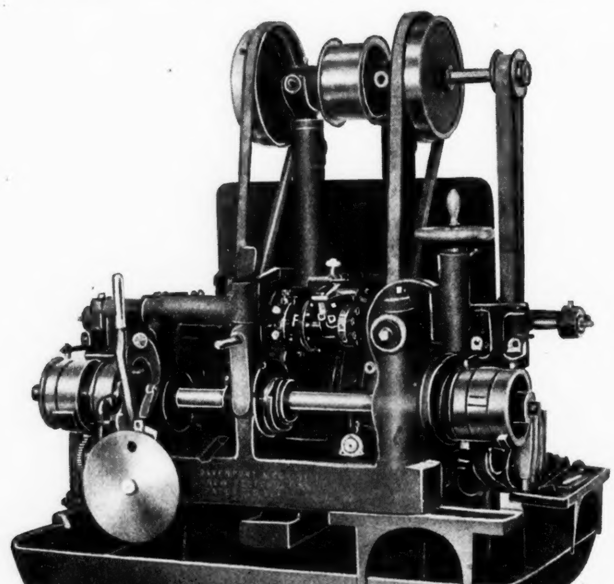


Fig. 5. Universal Automatic Staff Lathe, for Small Steel Pinion Blanks

about 20,000 turns a minute. Both spindles are hardened, and a high grade of workmanship is supplied throughout the machine. Change gears and index mechanism are provided for drilling from six to twelve holes. The needles are inserted and staked in place by methods commonly employed on such work.

Universal Automatic Staff Lathe

Another machine in this line is shown in Fig. 5. This is an automatic staff lathe, particularly adapted for turning the staffs with solid pinions, met with in small clocks and clock watches. The main features of this machine are the provision of two spindles in line with each other, and the special form of turret used.

One of the spindles, as in the regular automatic screw machine, is provided with automatic stock feed and collet mechanism. The second one, in line with it, has a similar collet or chuck mechanism, but is not provided with a stock feed. Its purpose is that of grasping the outer end of the work, so that the delicate staffs or pinion blanks are driven from both ends. This is essential on work of this character. Each spindle is separately driven from the self-contained countershaft of the machine; but in addition, there is a shaft back of

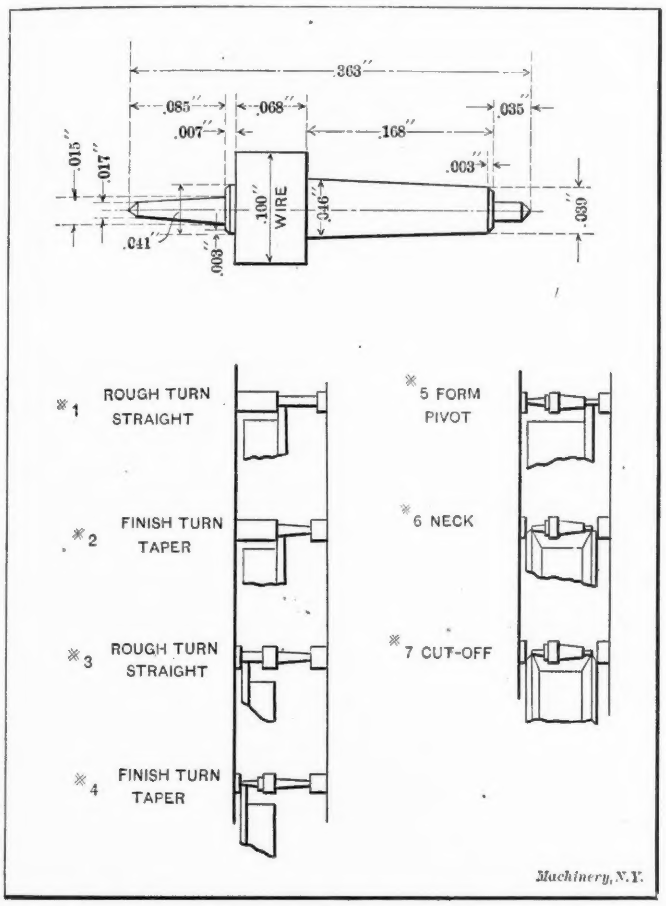


Fig. 6. Typical Order of Operations for Machine shown in Fig. 5.

the two spindles, connected with them by helical tooth spur gearing, which ensures their turning at exactly the same speed. This is essential to prevent small work from being twisted off. When the stock is fed it enters into the chuck of the second or supporting spindle, about 1/8 inch. After the pinion blank is completed and cut off, this piece is ejected before the next feeding of the stock.

The novelty of the turret lies in the fact that it has its axis parallel with the spindles, and has cam movements in line with the spindles for turning, and perpendicular to them for cutting-off, forming, etc.; and, furthermore, in the fact that circular forming tools similar to those ordinarily used for cross-slide work are employed. This construction makes it possible to use the same tool for forming and turning. After the tool is formed down to the desired diameter, it can turn lengthwise the same size; or it can turn taper, if desired, and as determined by the shape of the cams. This turret is really the old-fashioned clock lathe, described in connection with the lantern pinion turning machine, but made automatic, the tools being fed in the same way that the slide bar tools were fed in that lathe.

The tools used in this machine, as may be inferred from Fig. 6, are of the circular formed tool type. They are 1 5/8 inch diameter, and have 3/8 inch smooth holes, fitting on hardened and accurately ground pins in the turret. They are clamped with two screws each. There is a swing gage which can be brought down into position for setting the tool to the correct height to cut properly. This combination of a small hole in the tool and a gage for setting the height of the cutting edge, makes the setting of the tool after sharpening very rapid and accurate. For turning lengthwise, the periphery of the formed tools is notched in eight places, and side-relief is given them, this being done on the relieving attachment of the Hendey lathe. To ensure accuracy in the product, adjustable stop screws are provided for the diameters formed by each of the seven tools, while other screws are furnished for the lengthwise adjustment of each tool. Sizes and lengths are thus easily controlled. The work is usually kept within 0.00025 inch limit. Pivots as small as 0.015 inch for watches are easily made on this machine.

The operating cam shaft revolves slowly during the turning, through change gears; and quickly, and at constant speed, during the feeding of the stock. The handwheel for manually operating the feed is in a peculiar location, being mounted on a vertical shaft as shown. This has proved to be very convenient. The capacity of the machine is for stock up to 3/16 inch diameter. It feeds 1½ inch long and turns one inch long. The workmanship and materials used throughout are of the high character required for machines of this class. The ratchet disk shown at the front of the machine is arranged as a counter for setting the machine automatically when the number of pieces contained in a bar of stock of given length has been made.

Fig. 6 shows on an enlarged scale a sample of the kind of work produced on this machine, and the order of operations followed. The first operation is that of straight rough turning, the tool being fed in and then longitudinally to the required dimensions. In the second operation a similar tool is fed in, and then longitudinally, but it is slowly withdrawn during this longitudinal movement to form a taper as shown. The third and fourth operations of straight and taper turning are similar to the first and second, except that the tool in this case has a shoulder formed on it, which finishes the shoulder next to the body of the chuck. In the fifth operation the pivot at the right-hand end is formed. In the sixth operation a double form tool necks both pivots; and then, in the seventh and last operation, a similar tool cuts the pieces off.

GENERAL ELECTRIC IMPROVED SPEED CONTROLLER

The accompanying illustrations, Figs. 1 and 2, show different sizes of an improved type of speed controller, recently brought out by the General Electric Co., Schenectady, N. Y., and known as CR 162 speed controller. In this device the rheostats often used for the control of shunt-wound direct-current motors (one for starting the motor and the other for varying the motor field current for speed control) are combined in one box and operated by the movements of one rheostat arm.

Fig. 1. Speed Controller, Type CR 162, made by the General Electric Company, Schenectady, N. Y.

The device consists of a starting rheostat, the arm of which is provided with a projection carrying a sliding contact which moves over the contact buttons connected to the field resistance. An auxiliary arm on the right-hand side maintains a short circuit on the field resistance when starting the motor, and on the starting resistance when the arm is turned back for varying the running speed by regulating the field current.

When starting the motor, the starting arm, due to the action of a spring, cannot be left in position on any of the contact buttons, but must be turned to the right until it engages

the auxiliary arm and forces the latter to be retained by the no-voltage release coil. The auxiliary arm then withholds the spring actuating the starting arm and makes it possible to leave the arm in any position on the field contacts which will give the desired speed control of the motor. If the operator releases the arm at any position while it is being moved to the right during the starting period, it will immediately return to the "off" position. In case of voltage failure, the retaining coil is demagnetized and releases the auxiliary arm which, in turn, releases the spring which carries the starting arm to the "off" position, thus opening the motor circuit.

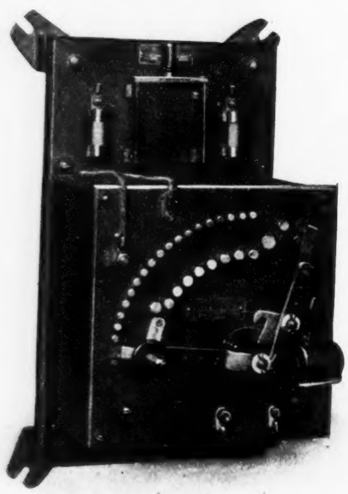


Fig. 2. A Controller of the same Type as shown in Fig. 1, Mounted on a Slate Base

The design of the rheostat makes it necessary to apply a little extra pressure to move the arm beyond the maximum speed point, thus calling the operator's attention to the maximum speed position. When it is desired to stop the motor, the switch arm is thrown to the "off" position, de-energizing the retaining magnet and releasing the auxiliary arm which then opens the motor circuit.

The maximum obtainable speed variation is 3 to 1. The controller shown in Fig. 1 is for a 35 H. P. motor, 115 volts current. In Fig. 2 another controller of the same type is shown mounted on a slate base together with a double pole switch and fuses. The controller described is also made with an overload release coil, and is then known as type CR 163.

MILLING ATTACHMENT FOR THE ACME MULTIPLE SPINDLE SCREW MACHINE

A time-saving attachment for finishing parts requiring to be milled, on the screw machine, made by the National-Acme Mfg. Co., Cleveland, Ohio, was illustrated in the July, 1909, issue of MACHINERY. Another milling attachment for use on the Acme multiple spindle automatic screw machine, shown

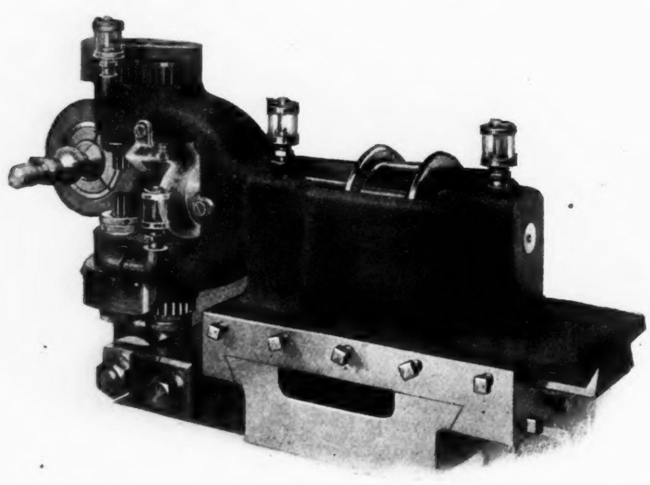


Fig 1. Milling Attachment for the Acme Multiple Spindle Automatic Screw Machine, showing Work Formed, Threaded and Milled in the Machine

in the accompanying engravings, Figs. 1 and 2, has recently been brought out by the same company. This attachment is especially intended for eliminating the handling in the milling machine of work of the character shown in the half-tone Fig. 3, this work consisting of a formed piece threaded on one end as shown, and having two flats milled as indicated. The making of this particular piece has always required two operations, one in the screw machine and one on the milling machine, the latter requiring the constant attention of an operator. The re-handling of pieces of that character is eliminated by the use of the attachment, which is fastened to the top of the slide carrying the cutting-off tool. The end mills shown are fed across the work by the cam movement which operates the cutting-off tool, and the increased movement necessary is obtained by the auxiliary lever shown in Fig. 2. The milling operation takes place at the same chucking as the forming and threading operations, and it will, therefore, be seen that the milling operation does not add to the time required for making the piece. The labor cost is

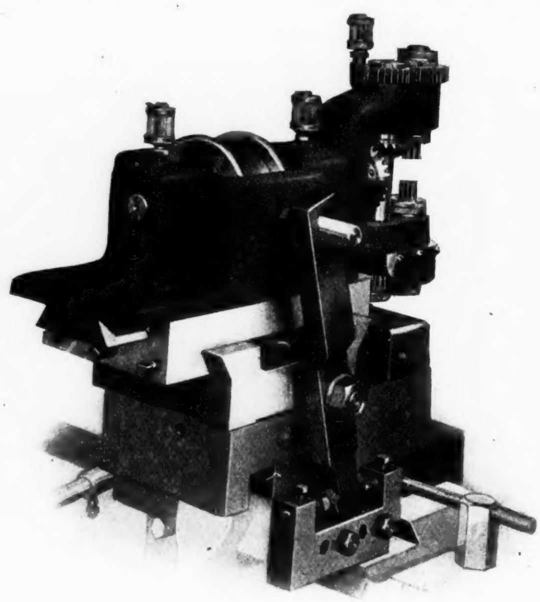


Fig. 2. Rear View of Milling Attachment, showing Feed Arrangement

very small, as the machine is taken care of by the regular operator with very little more attention than without the attachment. The mechanism of the device is simple and easily adjusted, and the attachment can be removed and put in place

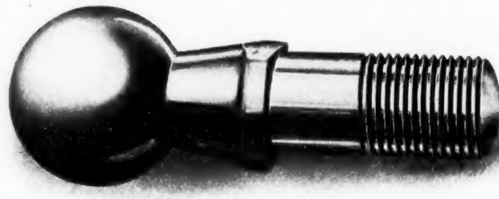


Fig. 3. Piece Milled on the Multiple Spindle Screw Machine

quickly. The cutters are driven from a pulley through bevel and spur gearing, as clearly indicated in Figs. 1 and 2.

SMITH & MILLS CO.'S GEAR-DRIVEN SHAPER

The Smith & Mills Co., of Cincinnati, Ohio, has recently brought out an improved design of back-geared crank shaper, which is illustrated in Fig. 1. As the engraving shows, the cone pulley has been dispensed with and an all-geared drive substituted. This new form of drive provides a simple and effective means for changing the speed of the shaper by the manipulation of one or two levers which are convenient to the operator; the danger incident to the shifting of a belt is also eliminated.

There are eight speed changes in all, four being obtained through the speed change gears and a like number through the back-gears. The speed change gears are divided into two sets of four each, which are contained in separate casings mounted on each side of the column at the rear. The arrangement of these gears and the way in which the various changes are obtained is clearly illustrated in Fig. 2, where the gear boxes are shown in section. As will be seen, the main driving shaft, which passes through the column, has mounted on it on each side a set of two gears which are free to slide longitudinally. Corresponding mating gears are also mounted on a secondary shaft above the main shaft, by which motion

is transmitted through the interior mechanism to the ram. By means of the lever C and a suitable connecting-rod, the different combinations of gears may be brougnt into mesh. Two changes of speed may be obtained by manipulating lever C when the small lever E at the back of the column, is in position A; by moving lever E to position B, two more changes are obtained, making four, and this number, as before stated, is doubled by the back-gears which are thrown in or out by lever D. As the engraving indicates, the shifting lever C is

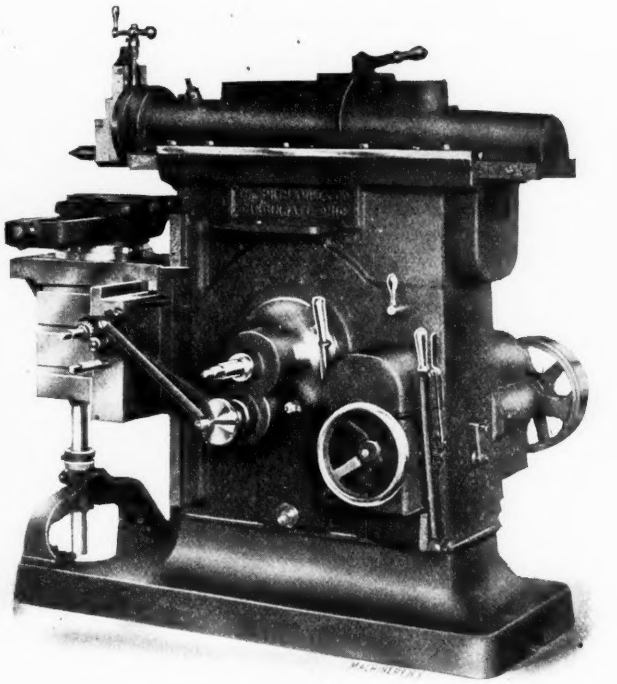


Fig. 1. Smith and Mills Variable All-geared Drive Back-geared Crank Shaper

provided with a latch and quadrant which makes it possible to firmly lock it and the gears in position.

It will be noted that tight and loose pulleys are shown in place on the main shaft in Fig. 2, whereas a single friction driving pulley is shown in Fig. 1. The former arrangement is fitted to standard designs, but the makers are prepared to furnish the friction driving pulley if this is desired. The company is also prepared to equip the machine with a complete self-oiling outfit, including a pump that will keep all

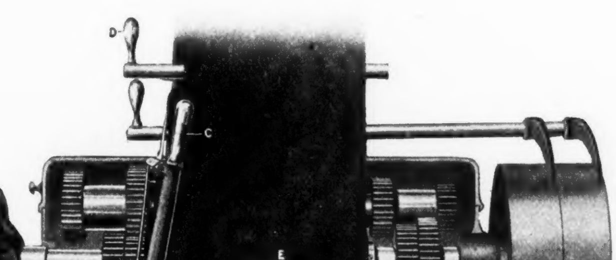


Fig 2. View showing the Arrangement of the Speed Change Gears

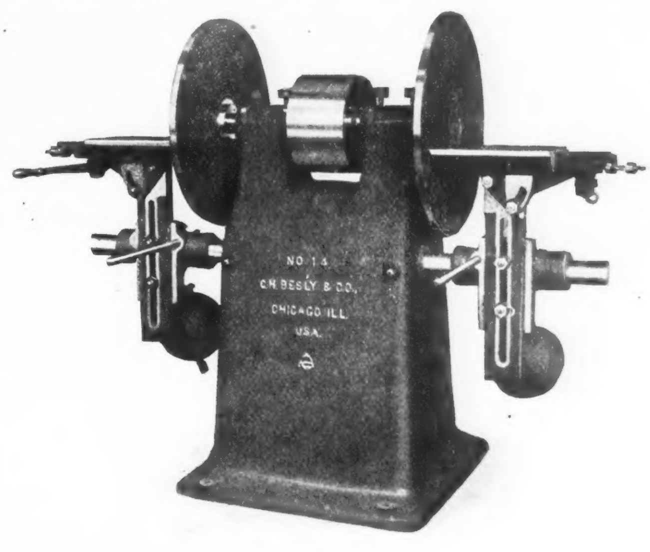
gears of the drive, as well as those in the column, constantly lubricated.

In addition to the improvements mentioned, this machine contains a numbers of others which are usually found on modern shapers. Among these may be mentioned the adjustable table support which not only gives rigidity to the table, but makes it possible to do more accurate work. If it is desired to have the machine electrically driven, the company recommends a No. 10 motor drive which consists of a projection or pad attached to the base for supporting the motor. Connection is made between the machine and the motor through a cast-iron gear and pinion on the main and armature shafts, respectively, which are connected by an intermediate rawhide pinion. These three gears are protected by a suitable guard. If a cheaper construction is desired, it may be had by placing the motor on the floor and connecting it with the machine by chain and sprockets.

These shapers are built in 16-, 20-, and 25-inch sizes. The weights of these three sizes for domestic shipment are approximately 2500, 3150 and 3950 pounds, respectively.

BESLY MANUFACTURING DISK GRINDER

The latest addition to the line of disk grinders manufactured by Charles H. Besly & Co., Chicago, Ill., is illustrated herewith. The principal distinguishing feature of this new grinder is its unusual size and capacity. The weight of the grinder complete is about 4000 pounds. The disk wheels, which are driven by a 7-inch belt, are 26 inches in diameter by 13/16 inch thick and weigh about 125 pounds each. Some idea of the machine's possibilities in the matter of output can be obtained from the fact that approximately 30 horsepower is required for driving, when it is being worked at its maximum capacity. In one instance, cited by the manufacturer, the tool, while being used for facing the bottoms of electric sad or flat irons had an output of 300 surfaces per hour and displaced



Besly Disk Grinder of Unusual Proportions

ten milling machines which were specially designed for this work.

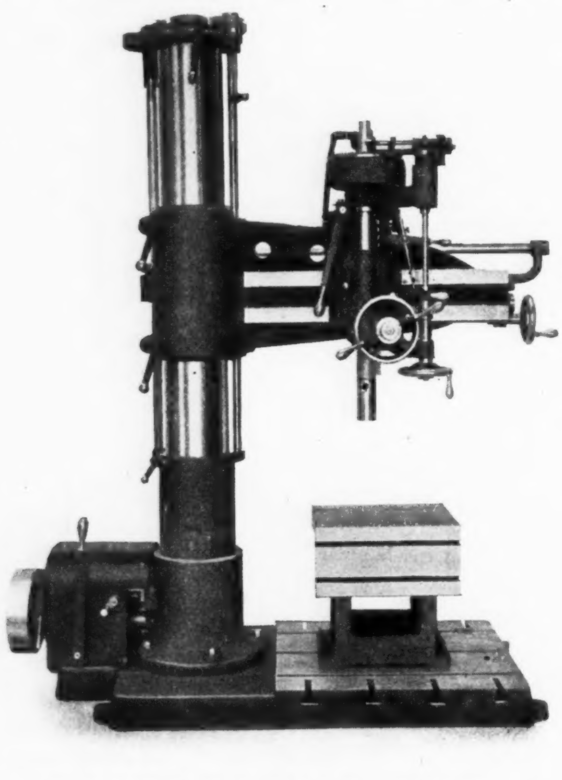
The tables, which have a working surface of 10 by 13 inches, are equipped with a geared lever feed. They are mounted on gibbed dovetailed slides and have a movement to and from the disk wheels of about 2 inches. This movement may be limited by an adjustable micrometer stop screw which is graduated to read to 0.001 inch, so that work may be ground accurately to size and duplicated. The makers state that these grinders are producing, commercially, cast iron printers' blocks to a given size within a limit of 0.0005 inch. Each table bed has two T-slots and a keyway for attaching angle-plates, magnetic chucks, or other forms of work holders in any desired position. The lever for feeding the table is comparatively short, but by the geared motion, a leverage of 14 to 1 is obtained, which makes it possible to force the work against the abrading disk with sufficient pressure to obtain efficient results without undue exertion on the part of the workman. The tables oscillate about a rockshaft and are adjustable in all directions; the weight of each is about 300 pounds. The end-thrust of the spindle is taken in either direction on a single bearing bushing by hardened and ground steel thrust collars. With this construction, the natural warming of the bearing, when running, does not tend to cause the thrust bearing to stick, owing to the fact that the expansion of the crucible steel spindle is greater than the cast-iron bearing bushing.

This grinder is designated as the No. 14-26-L. The design and construction throughout appears to be fully up to the standard of the best modern machine tools.

MUELLER RADIAL DRILL

The latest addition to the line of radial drills manufactured by the Mueller Machine Tool Co., Cincinnati, Ohio, is shown in the accompanying halftone. This tool, while not radically different from previous designs, has been simplified and is rigidly constructed throughout to adapt it to modern shop conditions.

In accordance with the usual practice of this company, the column is stationary, being firmly bolted to the base. It is



Mueller Radial Drill with Geared Speed-box and either Positive or Friction Feed

cast in one piece and has four internal webs, extending its entire length which add to its stiffness. To reduce the springing of the arm to a minimum, all columns are ground to size. The arm itself can be swung completely around the column and be instantly locked by a handle conveniently located. A graduated ring on the column enables the operator to set the arm to a definite position as often as desired. The arm can be lowered at twice the elevating speed, and its vertical movement is controlled by a lever located on the column cap. The head is traversed by means of a double-threaded screw, and it can be instantly locked to the arm by a small handle. A graduated dial connected with the traverse screw, enables the operator to adjust the head to within 0.001 of an inch. The back-gears, which are located on the head, can be engaged or disengaged without shock while the machine is in motion, by a lever that is located directly in front of the operator.

The feed mechanism gives eight changes in geometrical progression for each spindle speed, and is so arranged that either a positive or friction feed may be obtained. The construction and operation of this feed mechanism was fully described and illustrated in the department of New Machinery and Tools, January, 1906. Six variations in spindle speed are obtained through a geared friction type of speed box, which number may be doubled by the back-gears. The construction of this speed box is very simple and the different speeds may be engaged instantly and without shock. A handle for starting, stopping and reversing the spindle is conveniently located on the head. There is also a tapping mechanism on the head which is so arranged that very heavy tapping operations are possible. The tap may be backed out at an accelerated speed, and the spindle is caused to slip when the tap reaches the bottom of the hole.

The plain box table shown in the illustration is furnished with all machines. A universal table, plain swinging table, worm swiveling table or round table, can be had at an extra cost. These machines will be equipped, if desired, for any type of motor drive.

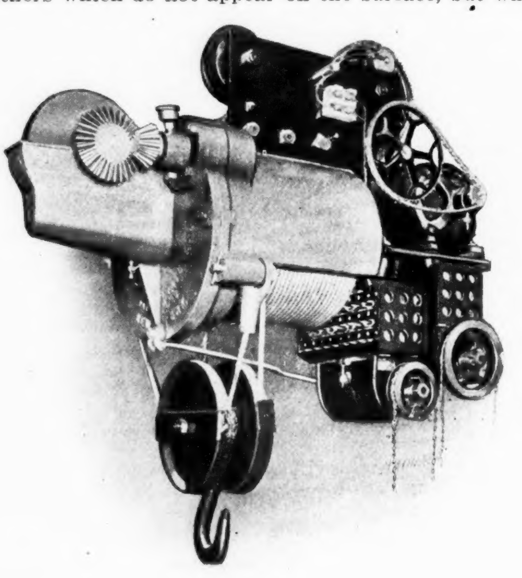
RASMUS FIVE-TON ELECTRIC HOIST

In the November, 1909, number of MACHINERY, we published a note describing a new form of electric hoist built by Gustav Rasmus, 514-16 West 57th St., New York City. This hoist was unusual in that the cable drum itself formed the field of the motor giving certain advantages which we will enumerate later. A new design of this hoist is herewith illustrated and described, which incorporates, among other improvements, an additional motor and mechanism for traversing the trolley on the I-beam.

In building this hoist the poles of a standard motor are removed from the field frame, and mounted on the interior of a cable drum of suitable diameter. The heads at each end of this drum are of special construction, to furnish bearings for the armature shaft which is placed within. These heads also are furnished with extension journals on which they and the drum itself are supported and rotated. The extension of the armature shaft carries a worm meshing with a wormwheel, which is, in turn, connected by bevel gears and spur pinions with the large gear on the cable drum. This, briefly, is the mechanical construction of the apparatus.

Besides the motor inside the drum, a second smaller motor is provided for traversing. This is mounted on a bracket to the right, as shown, and is connected by chain and sprocket, and spur gearing with one of the trolley wheels. Suitable controllers are mounted under the traversing motor bracket, provided with sprockets and operated by hand-chains from the floor.

The construction described has numerous advantages which are at once apparent from an inspection of the hoist, together with others which do not appear on the surface, but which do



An Unusual Design of Hoist, in which the Drum forms the Field Frame for the Motor

appear in the use of the device. Most important of all, the size, weight, number of pieces, over-all height and cost of the apparatus are greatly reduced over other designs. The mounting of the motor inside the drum does away with a great amount of bracing, supporting, etc., which would otherwise be required, and reduces the mechanism and framework to the simplest possible form. The over-all height of the apparatus is unusually small, being only 35 inches for a five-ton machine. This has been effected, as may be seen, without resorting to the expedient of reducing the diameter of the sheaves. In fact, these are larger than on other hoists of the same size, greatly adding to the length of life of the steel cable used. An automatic stop to prevent over-running is provided as shown, which acts directly on the controller through a mechanical connection.

One of the incidental advantages of the construction lies in the fact that the constant coiling and uncoiling of the cable on the drum serves to keep the latter (which, of course, is part of the magnet circuit of the field) constantly cool, even during rapid, heavy and continuous service. A drum section strong enough to carry the load is, by necessity, large enough for the magnet circuit. The area furnished by the cable as it is wound onto the drum, while not great, has the advantage of increasing the section as the speed of the hoist increases, and furnishes cool material at the same time. In lowering again, the extra section is unwound from the drum to cool in the air.

The worm drive employed has definite advantages of its own. The angle of thread is just within the angle of repose. On this account no brakes are required. This obviates the sudden straining of cables which results from the automatic setting of the brakes when the current is interrupted. The apparatus is thereby made very much safer in every way. The compactness and simplicity of the mechanism and the support given to all its parts reduces cramping and friction of every kind to the last degree. The maker is prepared to compare the efficiency of his hoist with that of any other on the market.

The hoist weighs complete as shown but 1000 pounds. The

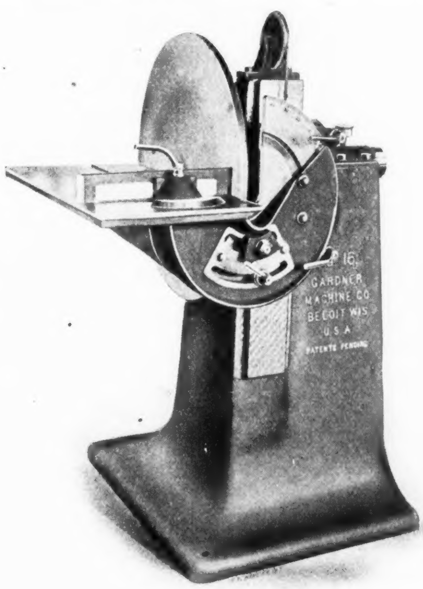


Fig. 1. Gardner No. 16 Patternmaker's Disk Grinder

head room required with the hook raised is but 35 inches, and the price is materially less than that of any other hoist of similar capacity on the market. The gearing shown exposed in the engraving is provided with guards, which are here removed simply to show the construction.

This hoist can also be furnished simply with the motor, winding drum mechanism and geared connections, for use in direct service in general hoisting.

GARDNER DISK GRINDER FOR THE PATTERN SHOP

The Gardner Machine Co., Beloit, Wis., has just added to its line of disk grinding machinery by putting on the market a patternmakers' disk grinder. This machine is built along the same general lines as a metal-working grinder, the fundamental principle of a revolving wheel faced with flint or garnet paper being adhered to; there are a number of interesting changes, however, which were necessary to adapt the machine to the work of the pattern shop.

A grinder of the single-ended type is shown in Fig. 1. These machines are also made double-ended; that is with disk wheels and work-tables at both ends. The work-table constitutes one of the interesting features of this tool. It is adjustable vertically and it may be locked in any position by means of two quick-acting bolts. The entire weight of the work-table is counterbalanced by a weight within the base of the machine, which is connected by a steel cable passing over a grooved pulley at the top, as shown. This counterbalance, of course, makes it comparatively easy to adjust the table. Provision is also made for tilting the table to any angle with the face of the wheel, and the angle at which it is set, is indicated by graduations on the segment at the end, which also forms the bearing. The inside top corner of the table always remains close to the working face of the wheel regardless of

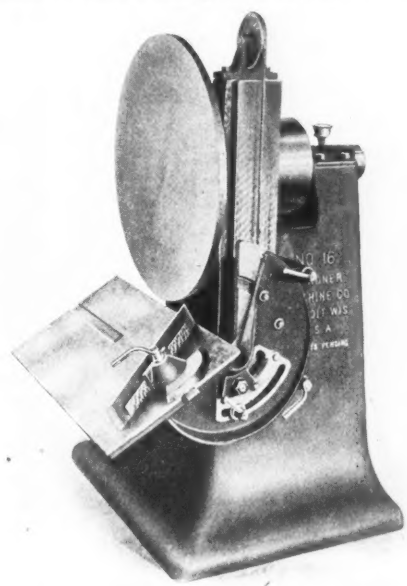


Fig. 2. Grinder with Table Inclined and Lowered

the angular position; the advantage of this arrangement is so obvious that further comment is unnecessary. The original construction of this work-table and its mounting, indicates that it has been carefully designed to insure convenience in handling and also to adapt it for the work of the pattern-maker.

In addition to the angular adjustment, the table is fitted with a special form of protractor or "square gage" as shown

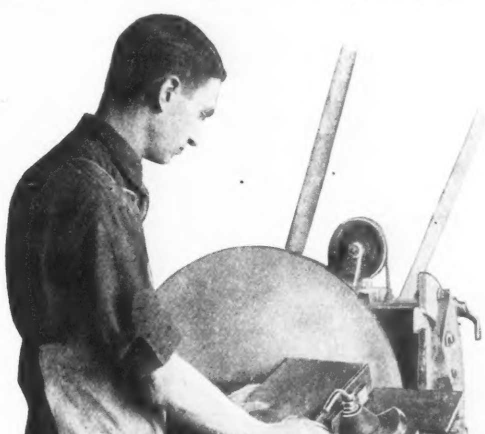


Fig. 3. Grinding a Double Angle on the End of a Pattern Part

in the illustrations. This gage is graduated from zero to 45 degrees in either direction, so that by using these graduations in conjunction with those on the head of the table, any combination of angles may be obtained quickly and accurately. Fig. 3 shows the machine being used to grind a double angle on the end of a pattern part and Fig. 4 shows how a built-up pattern is ground true and given draft at the same time.

This protractor is equipped with a gage bar which locates and guides the work at the desired angle. A slight turn of the screw handle shown locks both the protractor and gage bar.

The disk wheels, which may range in size from 24 to 30 inches, are readily refaced without removing them from the spindle, no press being required for the refacing operation. In Fig. 2 the table is shown lowered to give free access for refacing the wheel. These wheels are supported on a 2-inch crucible steel spindle that runs in long babbitted bearings which are reamed and scraped. The end-thrust in both directions is taken at the right-hand box on hardened steel collars 4 inches in diameter which give 9½ square inches of thrust

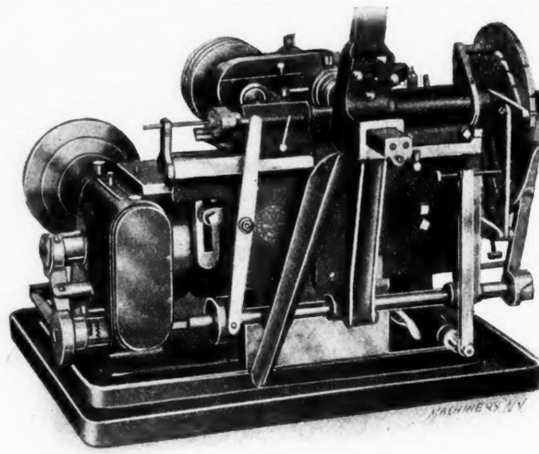
Fig. 4. Truing and giving Draft to a Built-up Pattern

bearing surface. These hardened collars bear against cast iron plugged with babbitt, so that if the spindle heats, the thrust bearing will not stick because of the unequal expansion. The spindle driving pulley is 10 inches in diameter with a 5-inch face, and the speed of the disk wheels is approximately 6000 feet per minute. Five horsepower is sufficient at all times for driving this machine. The weight of a single-ended grinder complete, with countershaft, is 12,000 pounds.

As this machine is equally effective for grinding knots, cross-grains, end-grains, hard or soft woods, and is not even affected by nails or screws, its efficiency as a pattern shop tool is apparent. The makers state that very favorable reports have been received from pattern shops where these grinders have already been installed, calling attention to the general efficiency of the tool and also to the ease with which accurate work may be finished in much less time than is required by the conventional methods.

WALTHAM AUTOMATIC PINION CUTTING MACHINE

In the February, 1908, issue of MACHINERY an automatic precision gear and pinion cutting machine, made by the Waltham Machine Works, Waltham, Mass., was illustrated and described. This machine, it will be remembered, is intended for small gears such as are used in various recording instruments, typewriters, clocks, etc. The magazine feed attachment was mentioned as one of the especially interesting features of the machine. When this magazine attachment is used the machine is entirely automatic in all its movements. An improvement in this magazine feed attachment has recently been made in the machine illustrated in the accompanying engraving, and by means of this improvement the production of the machine is materially increased. The improvement consists in stopping the main cam-shaft while the feeding operations are performed, instead of performing these operations during the time of the return of the slide after the last cut. This makes it possible to use a much quicker return of the work slide than was formerly the case. The feeding attachment automatically ejects the cut pinion and replaces it with a fresh blank, the movements being obtained from one

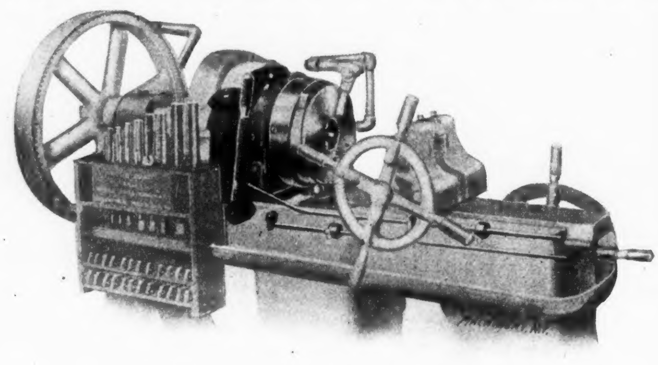


Automatic Pinion Cutting Machine with Improved Magazine Feed Attachment, made by the Waltham Machine Works, Waltham, Mass.

revolution of the cam-shaft attached to the work slide and operative only upon the completion of the last or finish cut. At that time the main cam-shaft stops, as mentioned, and starts again immediately upon the completion of the feeding operation. From 15 to 25 per cent may be added to the production of the machine by the use of this attachment. Its design is such that it is thoroughly reliable and not likely to get out of order.

"LITTLE GIANT" BOLT CUTTING, NUT TAPPING AND PIPE THREADING MACHINE

The accompanying half-tone shows a machine recently brought out by the Wells Bros. Co., of Greenfield, Mass., known as the "Little Giant" bolt cutting, nut tapping and pipe threading machine, the special feature of which is the automatic opening die head, the opening and closing of which is governed by the movement of the vise carriage. The die-opening mechanism consists of a cam ring with knock-out projection on the outside of the head, an upright spring stud



Bolt Cutting and Threading Machine built by the Wells Bros Co., Greenfield, Mass.

in the web under the head, a releasing rod which extends horizontally through the web from the spring stud to the outside of the bed, and two long rods carrying the adjustable stops at the side of the bed.

When the head is closed and the dies are cutting, the upright stud under the head is held within the supporting web so that its head is flush with the top surface of the web. The stud is mounted on a spring and is held down in the web by the releasing rod. When the rod support on the vise carriage strikes the stop shown, a pawl at the end of the rod is thrust

forward. As this pawl is mounted on the end of the releasing rod in the web, the forward movement of the pawl turns the releasing rod, and the upright stud springs up. The stud is so placed that it springs up just in front of the cam ring at its narrowest point, so that one revolution of the head with the edge of the cam ring bearing against the stud forces the head open and brings the knock-out projection around to the stud which is then "knocked-down" into the web and again locked. The rod extending from the hand lever shown to the end of the bed, parallel to the knock-out rod, is also provided with an adjustable stop and serves to close the head automatically when the vise carriage is run back. The heads can also be both opened and closed by hand, as in previous designs, if desired.

As compared with previous designs, the construction of the yoke over the back of the head has been made stronger. The yoke is linked to the yoke support at the top and to two forks on the lever shaft at the bottom, with toggle joints in the middle, one on each side. The yoke carries two segments, one on each side of the head, which fit into the groove in the back of the head. This form of construction gives ample power for instantaneous action.

In the operation of the machine, all that is needed is to put the work into the vise, set the stops, and the machine will do the rest. All holes will be tapped uniformly both as regards diameter and length, and blind holes can be tapped in work held in the vise, without difficulty. The machines equipped with automatic opening die heads are of 1-, 1½- and 2-inch capacity.

TAYLOR-WILSON REAMING MACHINE FOR PIPE COUPLINGS

The Taylor-Wilson Mfg. Co., McKees Rocks, Pa., has recently brought out a pipe-coupling or socket-reaming machine, which is adapted to couplings of a larger size than any machine previously manufactured by this company. The special features of this new tool, which is illustrated in Fig. 1, are its strength, simplicity and capacity for production.

The coupling is held in position while it is being operated on by a chuck composed of one stationary gripper and one

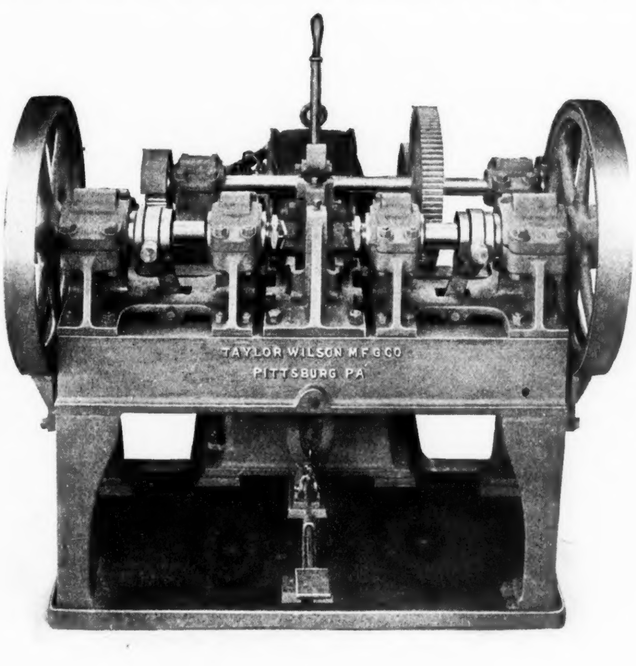


Fig. 1. Taylor-Wilson Pipe Coupling Reaming Machine

movable gripper. The movable gripper is actuated by a toggle joint, one member of which is a U-shaped spring. The purpose of this spring is to compensate for the variation in the diameter of the couplings due to the welding process; consequently when the machine is once set for couplings of any particular size, no further adjustment is necessary until a change of size is required. The toggle is operated by a hand lever, which extends above the center of the machine as shown. The coupling is placed in position to be gripped by the operator and is released by the opening of the chuck; it then drops through a chute which is located under the machine and is delivered into a receptacle provided for the purpose.

In Fig. 2 couplings are shown before and after the reaming operation has been performed. Both ends of the coupling are reamed simultaneously by tools which rotate in opposite directions. These tools are carried in heavy spindles, which rotate in bearings and are driven through cast steel cut gears, preferably by a variable speed motor. This motor, which is located at the rear, as shown, is connected by gearing with an

Fig. 2. Pipe Couplings before and after being reamed

intermediate shaft which, through a pinion on the end, drives the large spindle gear to the right, directly. The opposite end of this intermediate shaft drives the left-hand spindle through secondary gearing, which reverses the direction of rotation.

The necessary reciprocating movement is given to the tools and spindles by the foot of the operator through a treadle which is connected to a toggle-joint which in turn connects

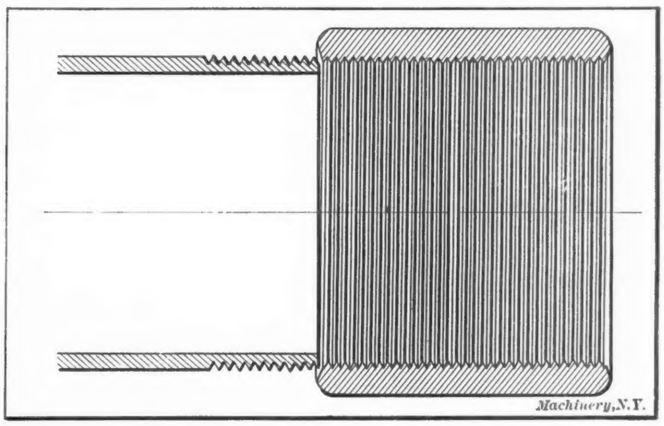


Fig. 3. Sectional View of Reamed Coupling

with the spindles by a pair of trunnions and levers. These levers are connected to the trunnions on the spindles on one end, and the toggle-joint on the other, and work about a pin near the center. The peculiarity of this movement is that when the tools, from a point of rest, are approaching the coupling to be operated on, the movement of the spindles is much greater than the movement of the treadle; but as the tools come near the coupling the condition gradually becomes reversed and the leverage of the treadle on the spindles becomes correspondingly greater.

The reaming of pipe couplings during the past few years has become almost as universal as tapping them, there being, of course, a number of advantages in having the couplings reamed. In the first place, reamed couplings make the process of tapping easier as all the fins which would interfere in starting the tap are removed. This will be understood by referring to Fig. 2. Another advantage in reaming couplings is that the thread is protected from injury in handling, as it starts at a point slightly back from the coupling end as shown in the sectional view Fig. 3. This beveled edge also acts as a guide when starting the coupling on the threaded end of a pipe. This is also made plain in Fig. 3. In addition to the foregoing advantages, a reamed coupling presents a neater appearance than one that has not been finished in this way.

This machine is self-contained and substantially built throughout, and all gears are properly protected by suitable guards. The builders claim that it is capable of very large

production; in fact, they cite one instance where an operator has been able to ream from 5000 to 8000 couplings, ranging in size from 2 inches down, in a day of ten hours.

ADDITIONS TO THE LINE OF FARWELL MOLDING MACHINES

In the accompanying illustrations we show a series of molding machines recently developed and placed on the market by the Adams Co., 623 White St., Dubuque, Ia. Figs. 1 to 6, inclusive, illustrate the construction and operation of a new pneumatic roll-over molding machine. Fig. 7 shows one of a line of new machines of the squeezer type.

Pneumatic Roll-over Molding Machine

The roll-over machine comprises mechanism for jolting the mold, turning it over to an evenly supported foundation, rapping the pattern, drawing it vertically, and then rolling the pattern back again ready for a new flask and a new mold. The machine is portable and of very simple construction. It is easy to operate, as all the heavy work is done by air.

The machine itself is shown in Fig. 1. The angle-plate frame *M* supports the flask. It is pivoted at one end to air cylinder *E*, and is supported at the other on heavy steel blocks *A*, resting on the cast-iron wheels *J*. The reason for the exces-

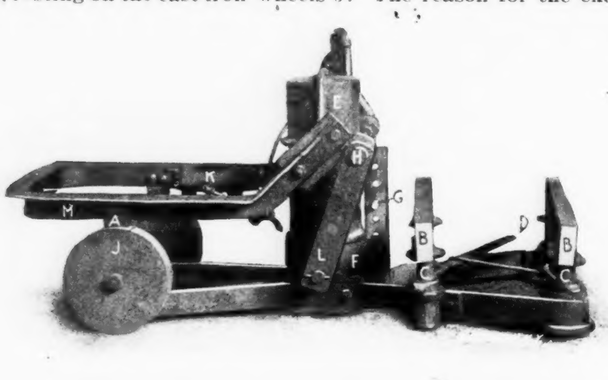


Fig. 1. Farwell Portable Pneumatic Roll-over Molding Machine

sive weight of wheels *J* and for supports *A* is shown in Fig. 2, where a mold is shown in place on the frame with the flask filled with sand. The workman is jolting the flask, as shown, by operating the air valve so as to alternately admit air to the cylinder *E* and release it. As it is admitted, cylinder *E* rises slightly on the stationary ram. This alternately raises cylinder *E* and with it frame *M* and the mold, and on dropping it down again, supports *A* strike the heavy wheels *J*. This continuous jolting shakes the sand thoroughly into place around the platen, and makes a compact mold. The holes shown in

Fig. 2. Jolting the Mold

M in Fig. 1 are for the purpose of attaching the pattern, as is more clearly seen in Fig. 6.

Operation of the Roll-over Machine

After jolting and striking off the top, the bottom board is placed in position and secured by adjustable clamps attached to the match-board. The molder then again opens the valve, as shown in Fig. 3, admitting air to cylinder *E* and raising the mold. As cylinder *E* rises, yoke *F* strikes stationary pin *G* (for all reference letters see Fig. 1) arresting its upward movement. The continuous movement of cylinder *E* then swings table *M*, and with it the flask and mold, about the pivot on the cylinder, through the action of the link *L*, which is pivoted to the frame at *H*. When the dead center is reached, the operator releases the air valve, allowing the mold to settle down on the other side of the dead center onto the supports

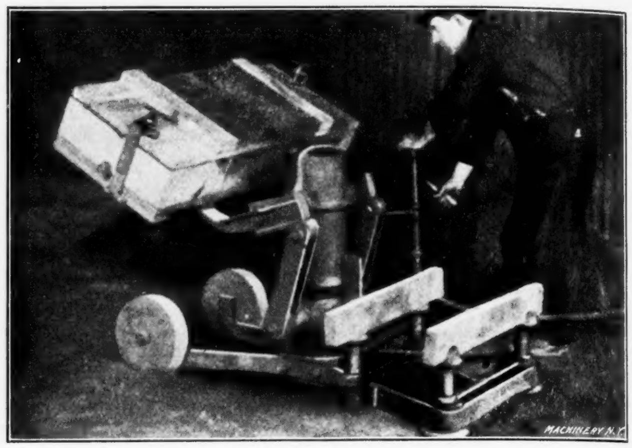


Fig. 3. Rolling over

provided for it, as shown in Fig. 4. This lowering can be done as quickly or slowly as desired.

Cross pieces *B* on which the mold now rests are supported on four plungers *C*, provided with springs so that they automatically equalize or adjust themselves at all four points to any irregularity of the bottom board. As soon as the mold rests on the cross pieces *B*, these plungers are locked in position by a single movement of lever *D* which is connected by links to all four plungers. This lever may be kicked into the locked position by the foot. The molder now releases the clamps and is ready to draw the pattern.

Fig. 5 shows the operation of drawing the pattern. With his left hand the operator opens a pet cock, admitting air to

Fig. 4. In Position for Drawing

the Adams pneumatic rapper shown at *K* in Fig. 1, which is mounted on the frame carrying the pattern. Being thus loosened, the pattern is simultaneously drawn by the operator's opening the air valve for cylinder *E*, with his right hand. The pattern is drawn perfectly straight, as the movement is directly vertical so long as cylinder *E* and yoke *F* are rising together. When, however, yoke *F* strikes stationary pin *G*, the pattern again rolls as before, over to the dead center. The receding of the air causes it to settle back again onto wheels *J*, describing an arc in its progress as shown in Fig. 6.

By adjusting the position of pin *G* any desired straight vertical movement can be obtained before starting to roll over. This, in combination with the pneumatic rapper and the steady air control, insures a clean and careful lift. In addition to this advantage, it will be seen that this machine has the features of great simplicity, a method of instantly clamping the plungers so that the mold rests evenly on them, the elimination of concrete foundations, portability, hinged clamps for match-board, flask and bottom-board, and easy control. The wheels may be arranged to run on tracks embedded in the

floor, thus affording an ample foundation at small expense, and avoiding the necessity of a permanent location of the machine at one place.

New Machines of the Squeezer Type

The machine shown in Fig. 7 is of the squeezer type, intended particularly for use with the hinged match-plate system invented by Mr. W. J. Keep of Detroit, Mich. This system employs hinged snap flasks and a match-plate, provided with lugs which fit into the hinges of the flask. This lines up pattern, cope and drag, and permits the whole to be turned over, so that both sides of the pattern may be molded at one time. In order to allow for this, the squeezer top is arranged so it will swing farther back, and the table is supplied with a special flask-supporting device not shown in the photograph. This device supports the back side of the drag while the cope is rolled up, and is required to prevent the drag from being tilted by the weight of the cope. The makers of this squeezer will supply it, together with all the special equipment required, to any foundry licensed to use Mr. Keep's invention.

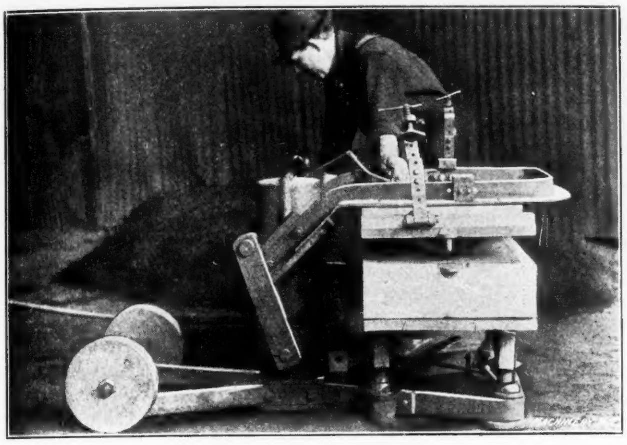


Fig. 5. Drawing the Pattern

Another new product is a 34-inch portable low-down heavy-duty squeezer. This is an intermediate size between the 30- and 38-inch machines, but possesses some special advantages not found in the older designs. The principal improvement is a new style of counterbalancing spring which is adjustable to any tension. This can be set so that the squeezer top will come forward by itself, though it is ordinarily adjusted so that the top stays out of the way until the mold is ready, when it will come forward with a very slight pull.

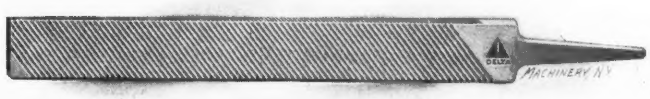
Fig. 6. Rolling Pattern Back to Molding Position

Still another addition to the line of squeezers is a 24-inch stationary machine similar in construction to others of the same make, except that the table is raised higher above the rocker shaft. With this table it is not necessary for the top to swing through so great an arc for clearing the table. This makes it easier to spring the top forward into the squeezing position. At the same time it brings the mold up above the operating links, so that a larger flask can be used in proportion to the width of the machine. This avoids all danger of the molder's striking his knuckles against the links when riddling the machine. This will take a flask 18 inches long, or within 6 inches of the total width; whereas on the ordinary 30-inch squeezer, measuring 30 inches between the side rods, no flasks longer than 22 inches are handled conveniently.

Fig. 7. A Machine of the Squeezer Type, adapted to the Keep Match-plate Process

"DELTA" HAND UTILITY FILE

A new type of file has been placed on the market by the Carver File Co., Philadelphia, Pa. This file, known as the "Delta" hand utility file, is intended for general use among mechanics and more particularly for machine shops. In addition to being adapted for use on metals, such as soft steel, iron, brass castings, etc., it can also be employed on wood, marble and similar materials. These files are made of high carbon crucible steel, which is especially hardened and tempered. As the engraving shows, the teeth are very coarse or of large pitch, the file being designed to cut rapidly and smoothly and at the same time to clear freely.



"Delta" Hand Utility File for General Work

RYERSON PORTABLE CYLINDER BORING-BAR

The portable boring-bar shown in Fig. 1 has been added to the line of machinery manufactured by Joseph T. Ryerson & Son, Chicago, Ill. This bar was designed primarily for boring locomotive cylinders, but it may also be used with satisfactory results for such work as stationary engine cylinders, steam hammer cylinders, air hoists and work of a similar character.

In addition to being of heavy construction throughout, this boring-bar possesses a number of novel features, prominent among which may be mentioned the feeding mechanism. The old, so-called "star" feed is entirely eliminated and a positive geared feed substituted; this gives a continuous feeding movement to the cutting tool which results in a smooth cut, as the tool does not dig into the metal. In the engraving the feeding mechanism may be seen at the right end of the bar. The feed-screw, which feeds the tool-head along the bar, is actuated by the gearing shown at the end. When the bar is set up for boring a cylinder, a weight is suspended from the handle of the crank inserted on the pinion shaft, so that when the boring-bar rotates, the feed-screw is caused to turn in relation to it. Were it not for this weight, the pinions on the shaft with

the crank, as well as the feed-screw, would remain stationary with relation to the bar. This simple method of obtaining the feed makes it possible to easily adjust the tool at any time by simply turning the crank, as the suspended weight would not seriously interfere. For rapid adjustment of the tool-head, however, a handwheel is provided which may be used to turn the feed-screw direct. By means of change gears, which are mounted on the shaft with the long crank, two feeds are obtained on the No. 1 or 4-inch bar, and three feeds on the No. 2 or 6-inch bar. Thus a light or heavy feed may be had by merely shifting the gears, or both gears may be disengaged and the feed thrown out entirely.

It will be noticed by referring to Fig. 2 that the tool-head

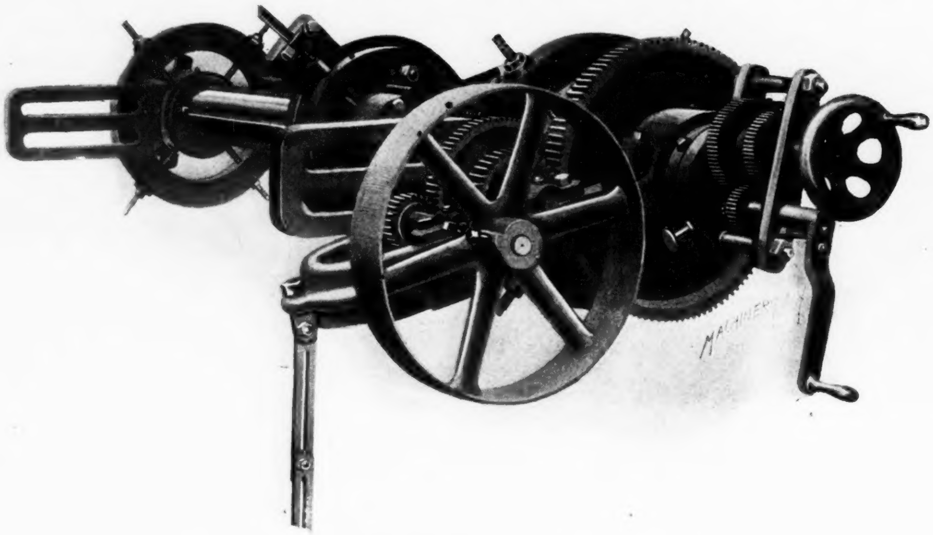


Fig. 1. Ryerson Cylinder Boring-bar with Adjustable Geared Feed

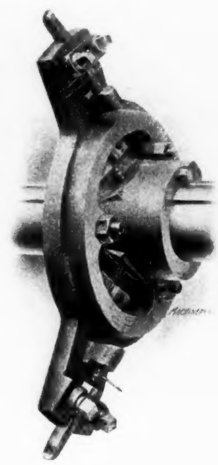


Fig. 2. Tool-head designed to permit Use of Straight Tools

is designed to permit the use of straight boring tools, the latter being set at an angle so that a cylinder may be bored without tearing down the guides and removing the back head. With some types of tool-heads it is necessary to use bent tools in order that the cut may be finished before the tool-head comes in contact with the head of the cylinder. The disadvantage of the bent tool lies in its flexibility and tendency to chatter. Tool-heads of different sizes may be easily attached to the bar, as there is a permanently located master-head so arranged that other heads may be positively fitted to it. This master-head has a long bearing which insures smooth cutting with a minimum of vibration.

All of the principal parts of this bar are made of steel. The frame containing the driving gears is of cast steel and it is so designed that it may be easily and quickly removed. The bar itself is accurately ground to size and cut gears are used throughout. These boring-bars are made in two standard sizes designated as Nos. 1 and 2. The manufacturers are prepared, however, to furnish special machines for boring cylinders of any length. The No. 1 machine will take cylinders from 9¾ to 30 inches in diameter and up to 44 inches in length where there are clearance blocks on one end of the cylinder only. If the bar is located in the stuffing-box of the back head, it will bore to a length of 50 inches. The No. 2 machine will bore diameters ranging from 20 to 50 inches, and lengths, with clearance blocks at one end, up to 35 inches. When the end of the bar is located in the stuffing-box, the maximum length is 46 inches.

These machines can be arranged for either pulley drive, direct gear drive, or with a Morse taper shank for operating with air or electric drills. It is customary in most railroad shops, to employ a motor with a capacity from 2½ to 3½ horsepower.

The approximate weight of the No. 1 or 4-inch bar with equipment necessary for diameters up to 13 inches is 1000 pounds. This machine, when furnished complete for boring to the maximum diameter of 30 inches, weighs 1500 pounds. The approximate weight of the No. 2 or 6-inch bar, varies between 3000 and 3700 pounds, depending upon its capacity.

REED QUICK-CHANGE GEAR MECHANISM

The accompanying illustration, Fig. 1, shows an engine lathe built by the F. E. Reed Co., Worcester, Mass., provided with a new patent quick change gear mechanism which may be applied to the company's 14-, 16-, 18-, and 20-inch lathes. The illustration, Fig. 2, shows a detailed view of the change gear mechanism proper. This illustration is a phantom view of the device so that all the gearing is indicated, although on the lathe itself it is carefully covered by suitable cast gear-guards. The simplicity of the design and the small number of parts are clearly indicated in this illustration. The gear case is securely fastened to the front of the bed and contains a shaft on which is mounted a cone of gears, any one of which can be instantly engaged by the movement of the lower lever shown. Another shaft is located above the cone of gears. This shaft is in line with the lead-screw and connects with it by means of the clutch operated by the knob at the right. When this clutch is released, it brings a gear into mesh with another gear on the feed-rod, this arrangement insuring that both the lead-screw and the feed-rod cannot be thrown into operation at the same time. On the same shaft a double clutch gear is provided which is operated by moving the upper lever to its three different positions.

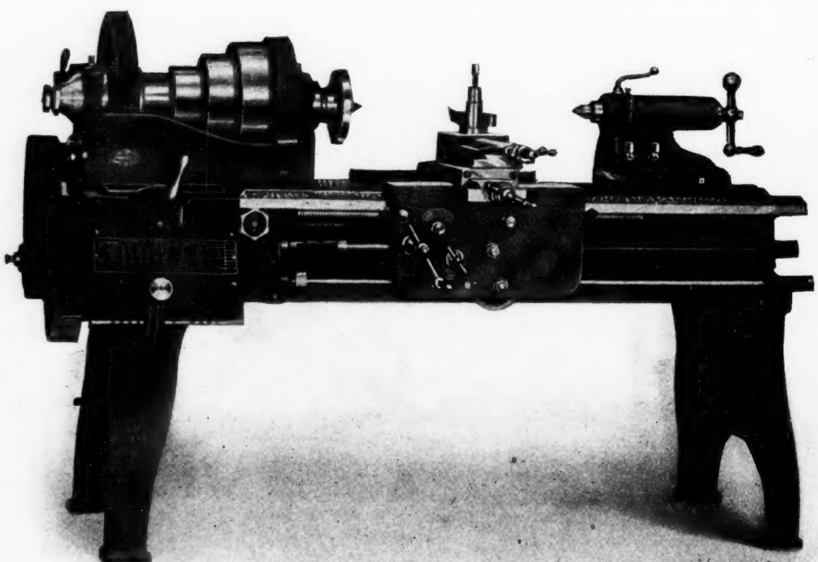


Fig. 1. Reed Lathe provided with Quick-change Gear Mechanism

The combination of the changes thus obtained with the two changes obtained by sliding in or out a gear at the end of the lathe provides for not less than sixty changes of speed for both lead-screw and feed-rod. This is an unusually large number of changes with so simple a mechanism. All gears in the front case are made of steel, are of coarse pitch and are practically unbreakable in service. The whole device is so designed that, in whatever position, the levers and sliding gears will not lock the mechanism and cause breakage. At the same time it is so simple in its arrangement and operation that it can be readily understood and operated by comparatively inexperienced workmen.

The index plate, not shown in the detailed view, but indicated in Fig. 1, is mounted on the front of the gear case. The plate clearly indicates the location of the levers for all

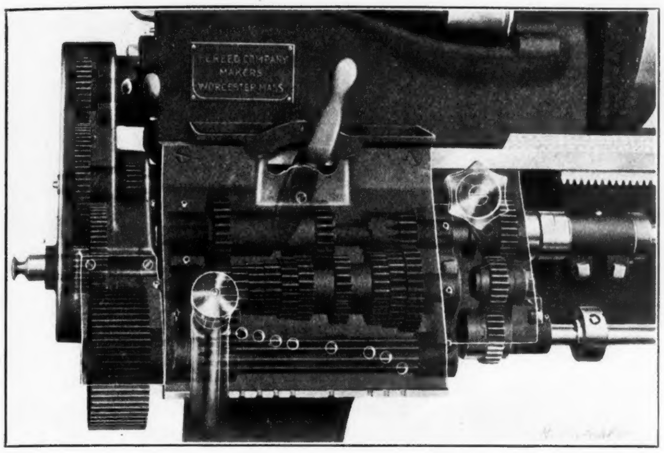


Fig. 2. The Quick-change Gear Mechanism of the F. E. Reed Co.'s Lathe

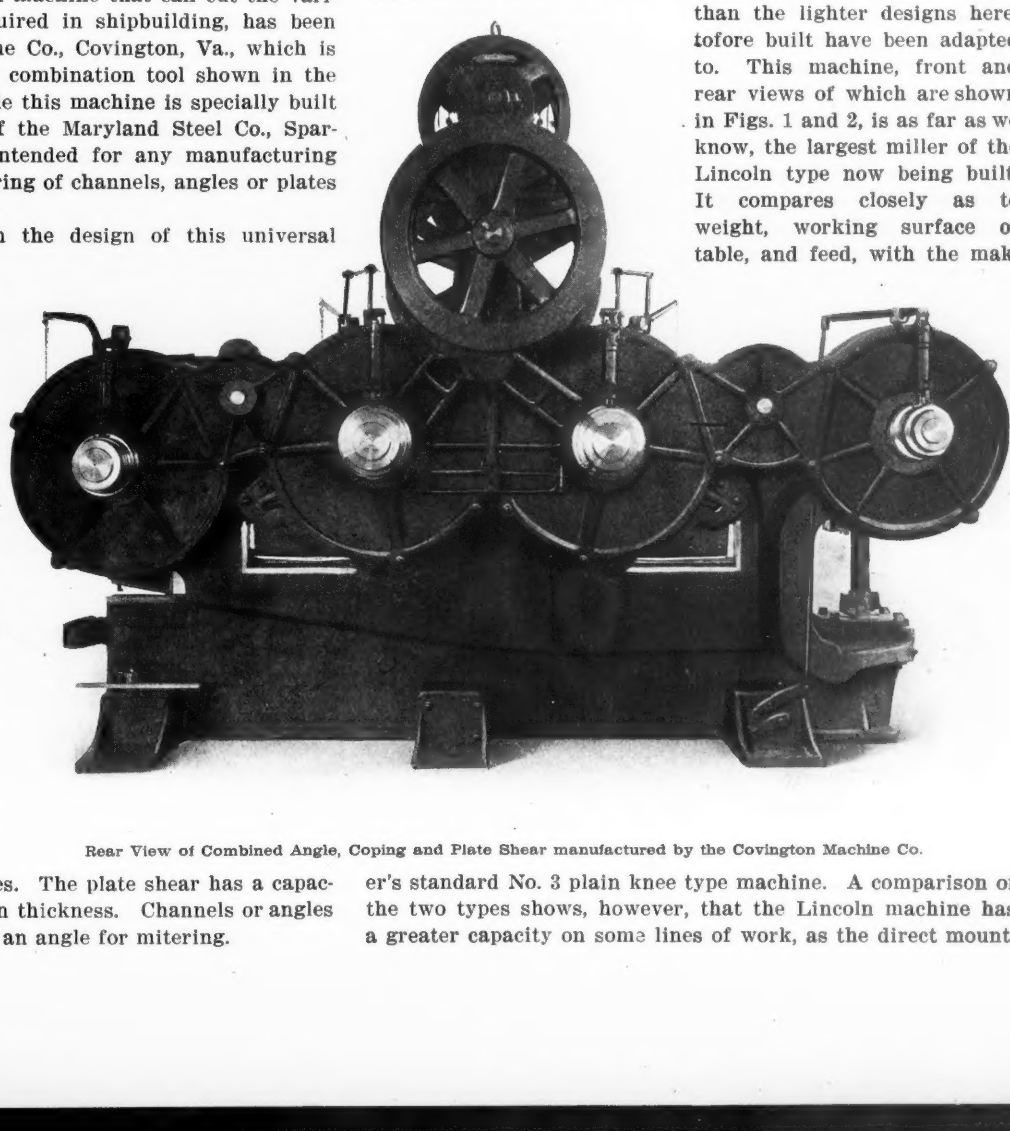
threads and feeds. Standard threads from 2 to 128 per inch, including $11\frac{1}{2}$, can be cut, and feeds from 10 to 640 per inch can be obtained.

COVINGTON UNIVERSAL SHEAR FOR CHANNELS, ANGLES AND PLATES

The need in shipyards for a machine that can cut the various channels and angles required in shipbuilding, has been met by the Covington Machine Co., Covington, Va., which is now manufacturing the large combination tool shown in the accompanying halftone. While this machine is specially built for the marine department of the Maryland Steel Co., Sparrows Point, Md., it is also intended for any manufacturing establishment where the shearing of channels, angles or plates is done in quantity.

The most novel feature in the design of this universal shear, lies in the combination of four tools in one compact unit. It is provided with a coping attachment at one end, a plate shear at the other and two angle shears in the center of the frame. These angle shears operate at an angle of 45 degrees, thus securing a vertical and horizontal shearing action. Each shear is controlled by its own clutch, and the machine may be operated by different groups of men all working at the same time without interfering with each other.

The angle shears in the center have a capacity for cutting channels up to 15 by $\frac{3}{4}$ inch, and 6 by 6 by 1 inch or 8 by 8 by $\frac{3}{4}$-inch angles. The plate shear has a capacity for material up to 1 inch in thickness. Channels or angles may be cut either square or at an angle for mitering.



Rear View of Combined Angle, Coping and Plate Shear manufactured by the Covington Machine Co.

The four tools are driven by one motor which develops 25 horsepower. This motor is mounted at the top of the machine in the center, as shown in the illustration, which is a view taken from the rear to more clearly show the general arrangement of the driving gearing and the automatic stop clutches. A pinion on the motor armature shaft engages a large gear located on an intermediate shaft on which two flywheels are mounted, one at each end. The motion is transmitted from this intermediate shaft to a second shaft just below it, which carries a pinion engaging with the two large gears which operate the central or angle shears. These two gears are also connected through pinions to the large driving gears of he coping and plate shears at the ends.

A patent stop motion is used, which automatically throws out a clutch on each shear when the latter reaches its highest point. To again start a shear, it is simply necessary to pull a chain, which is suspended at a convenient point. These chains are connected with the single-revolution clutches, through counterbalanced levers as shown. For the coping attachment, which may also be used for punching, the stop mechanism is adjustable so that the plunger may be stopped at any point of its own stroke. This allows the tool to be brought close to the work, so that the latter can be properly adjusted.

The frame, plungers, clutches, and all parts subject to shock, are made of semi-steel castings. Hammered steel shafts containing from 0.4 to 0.5 per cent carbon are used. The gears are provided with long sleeve hubs and are thoroughly protected by guards which are bored to receive them. The question of lubrication has been given special consideration. Arms, which are provided for supporting the angles or channels while they are being cut, are so designed and placed that they do not interfere with plates that are being sheared, as the latter pass under them. The weight of this machine is about 23 tons.

LARGE DOUBLE-HEAD LINCOLN MILLING MACHINE

The Hendey Machine Co. of Torrington, Conn., is now manufacturing a double-head milling machine of the Lincoln type, which is intended to handle a heavier class of work than the lighter designs heretofore built have been adapted to. This machine, front and rear views of which are shown in Figs. 1 and 2, is as far as we know, the largest miller of the Lincoln type now being built. It compares closely as to weight, working surface of table, and feed, with the maker's standard No. 3 plain knee type machine. A comparison of the two types shows, however, that the Lincoln machine has a greater capacity on some lines of work, as the direct mount-

ing of the table and saddle on the bed gives it a more rigid support than is afforded with the column and knee construction.

On the standard size machine, the table has a working surface of 15 by 54 inches. There is an automatic cross-feed of 36 inches and a longitudinal adjustment in line with the spindle of 12 inches. The table is fitted to the saddle with an angular lock and taper gib, and it has a length of bearing on the saddle of 34 inches. A bearing contact on the shoulders of the saddle supports the table clear to the edge, thus enabling work to be machined to its full width without any tendency to spring under the cut.

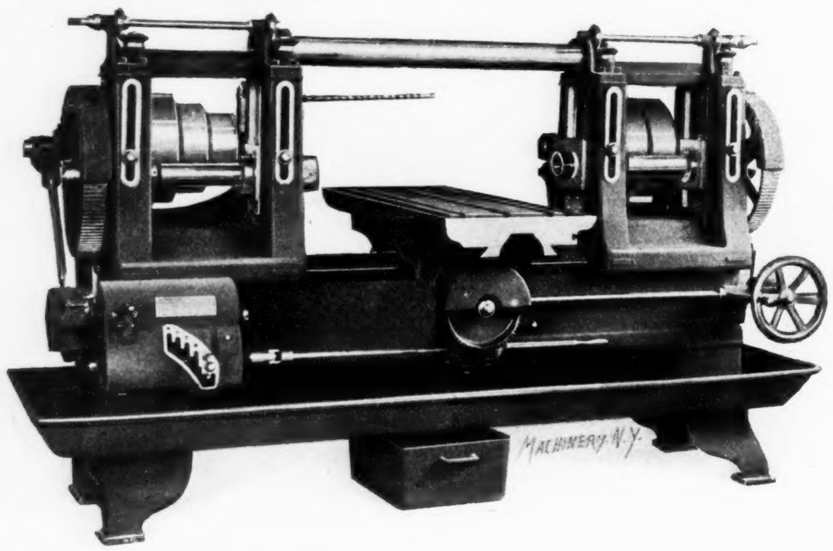


Fig. 1. Double-head Lincoln Milling Machine built by the Hendey Machine Co.

The feed movement is positively obtained direct from the driving spindle through gearing and shafts. There are twelve changes of feed available, ranging from 0.010 inch to 0.130 inch per revolution of the spindle. The feed motion is reversed by means of a toothed clutch operating between right and left bevels. This reversing mechanism is enclosed in the box at the left of the machine (Fig. 1), which receives the ends of the transmission shaft from the driving spindle and the gear-box cone shafts. The feed worm, which is free to slide on the splined feed shaft, is carried in a self-contained bracket, which takes all the end thrust from the feed shaft when a cut is being taken, and thus prevents any twisting strain on the saddle. This worm is well lubricated, as it runs in an oil bath in a pocket of the bracket. The feed mechanism is mounted entirely on the outside of the bed, thus making it unnecessary to core holes in the bed for feed connections.

The main spindles are made of hammered steel forgings and have 1¼-inch holes through their centers. Taper journals are provided at both the inner and outer ends, and the bearings are cast annular and are bushed with Lumen bronze. The ends or noses of the spindles are 3½ inches in diameter, and they are threaded 3½ per inch, left-hand. Slotted driving collars for arbors are fitted to the nose of each spindle, and No. 12 Brown & Sharpe taper holes are provided.

The cone pulleys on the driving shafts have three steps, and the driving belts have a width of 4 inches. The ratio of gearing between the driving shafts and spindles is 6 to 1, the width of the gear faces 2¾ inches, and the diametral pitch 6. The driving shafts are carried in rocking frames by which quick adjustment can be made when the spindles are raised or lowered, and which constantly maintain the shafts in parallel alignment with the spindles. Binding bolts are provided for locking these frames securely in place after an adjustment has been made.

The elevating and lowering mechanisms for the spindles, which are located on top of the head-blocks, are fitted with micrometer dials reading to thousandths of an inch, so that accurate vertical adjustments can be obtained. The spindles are held securely in a fixed position, after being set, both by means of the elevating screws and also by binding bolts which pass through the upper part of the boxes, as shown. These bolts serve to clamp both the uprights and the boxes firmly together, after the spindles are adjusted to the desired elevation.

Both the head-blocks and saddle are gibbed to the bed with angular locks to insure a perfect alignment of the spindles with the travel of the table. A hand adjustment of the table is secured by the large handwheel shown bracketed to the right end of the bed in Fig. 1, and the saddle adjustment is obtained by means of a screw which passes through the center of one head-block casting and is mounted in a bracket at the end of the bed. This screw, which is more plainly shown in Fig. 2, has a graduated dial reading to thousandths, thus permitting accurate longitudinal adjustment of the table.

These machines are built with six different lengths of bed, ranging from 62 to 97 inches, and with tables either 15 or 20 inches in width. The maximum distance between the heads for the six different bed lengths, ranges from 15 to 50 inches, while the maximum distance between the spindle noses varies between 9 and 44 inches.

* * *

NEW MACHINERY AND TOOLS NOTES

Quick-acting Swivel Vise: Charles Parker Co., Meriden, Conn. This is a swivel vise which may be adjusted instantly to any desired position and tightened by a single movement of the hand. It is mounted on a swiveling base, permitting it to be set at any position convenient to the operator.

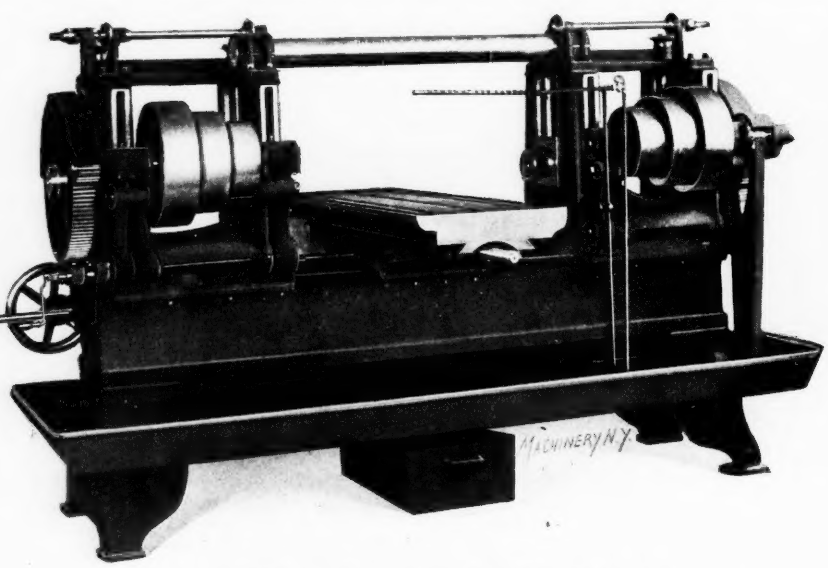


Fig. 2. Rear View of the Double-head Lincoln Milling Machine

Pressed Steel Gearing: Johnston Pressed Gear Co., Ottumwa, Ia. This firm is furnishing steel rims for gears, having teeth of successive folds made in a strip of steel. It is intended for slow, heavy work, and is said to be superior in strength to cast gears of the same pitch and width of face.

Oilstone Holding Handle: F. J. Badge, 286 Taaffe Place, Brooklyn, N. Y. This tool consists of a handle with suitable clips, whereby oilstones of various sections such as round, square, flat, triangular, etc., can be held for toolmakers' use. It should be very convenient in lapping dies, "touching up" fine tools, etc.

Self-contained Ventilating Outfits: B. F. Sturtevant Co., Hyde Park, Mass. These outfits comprise a small motor with a direct connected multiple vane blower, which may be quickly located in any position and connected with a lamp

socket. They can be used for exhausting vitiated air or supplying fresh air from the outside.

Double Inserted Blade Tool-holder: Colton Combination Tool Co., Chester, Vt. This tool-holder provides for the use of two blades, the second of which is set slightly ahead of the front one so that roughing and finishing cuts can be taken. With this arrangement a fine finish can be given, even while the leading blade is removing a heavy chip.

Power Hammer: New Metal Tool Steel Co., 338 Cumberland Ave., Portland, Me. This hammer provides for ready adjustment, both of the force of the stroke and of its length, while the machine is in operation. It is of the crank and pitman type, with a spring helve which gives the form of blow which has been found most desirable for machine forging.

Standard Punch and Holder: American Die & Tool Co., Reading, Pa. This is an improved construction which permits making the punch of smaller stock than usual, thus lessening its cost. As in previous designs, the strain is taken by the direct bearing of the punch on the stub of the ram, so that full strength for resisting the cutting strain is provided.

Portable Oxy-acetylene Welding Apparatus: F. C. Sanford Mfg. Co., Bridgeport, Conn. This outfit is a smaller size of the apparatus described in a note published in the December, 1908, number of MACHINERY. It is adapted to a wide range of work in welding, cutting, etc., with the high temperature flame. It operates on chemicals which may be bought in the open market.

Spring Controlled Collets for Speed Lathes: Garvin Machine Co., Spring and Varick Sts., New York City. With this design of collet mechanism the gripping of the sleeve at the rear end of the spindle, while the lathe is in motion, releases the work. When the sleeve is released the chuck is closed by spring pressure. It is very rapid in operation, as it is not necessary to stop the spindle on ordinary work.

Combination Wrench Set: C. M. B. Wrench Co., Syracuse, N. Y. This set of wrenches comprises a ratchet handle, sockets for bolts and nuts of various sizes, together with extension sockets, screw-drivers, etc. This permits a wide range of work to be done in all sorts of inaccessible places. The wrenches and universal joints are made of a non-rusting alloy, and the connections are of square section steel tube.

Self-Lubricating Bearing Metal: New Era Mfg. Co., Kalamazoo, Mich., has brought out an anti-friction alloy in which the metal portion is reduced to a sponge-like form, highly attenuated and of irregular or interrupted surface formation. The metal is treated with lubricating oil and is then coated with mineral lubricants making a compound mass of metallic packing. It is used for packing piston rods, valve stems, and as a bearing metal for lining journal boxes, bushings, etc.

High-speed Steel Treating Furnace: C. U. Scott, Davenport, Ia. This is a furnace of improved construction which, it is said, makes possible the heating of high-speed steel tools to the high temperatures required, without any scaling, pitting or blistering. Even polished steel can be treated so that it will be free from scale. This result is obtained by doing away with the door and the combustion chamber. Provision is also made for confining the heating to the cutting ends of tools.

Bench Milling Machine: B. C. Ames & Co., Waltham, Mass. This is a miller of the precision type, built on the general lines of the standard column and knee type machine, though, of course, of much smaller size. It is provided with a lever feed for the horizontal table movement, and is furnished with swiveling vise and index head. The latter may be set at any angle from 10 degrees below the horizontal to 5 degrees above the perpendicular. The table has a working surface of 12 by 3 inches.

Mica Annealing Mixtures: United States Mica Co., Chicago, Ill. This is a substance prepared from mica which is used for annealing in the same way in which charcoal, etc., are used now. Its inertness to chemical combinations and its non-absorbent qualities result in the production of a clean surface on the steel, without oxidization. The material is an exceedingly poor conductor of heat, so that the cooling takes place very slowly, giving the best results in annealing.

Inserted Tooth Milling Cutter: Union Twist Drill Co., Athol, Mass. These cutters use inserted teeth instead of blades. The teeth are set into drilled holes, and are made from round stock. They are held in place by being split longitudinally for the greater part of their length, and are provided with taper pins in the splits, the driving of which locks them firmly in place. To remove the teeth when they are all ground away, the taper pin is drilled out, it being left soft for this purpose.

Arch Type Press: Blake & Johnson, Waterbury, Conn. The distinctive feature of this press is the type of adjustment used for the ram. The ram is split in two parts, held together by a double, dovetailed wedge, which is controlled by a fine screw adjustment. This device puts into the hands of the operator a means for making minute changes in the depth of the ram stroke, which is controlled with the greatest delicacy. It will be seen, therefore, to be particularly adapted to sub-press work.

Automatic Buffing Machine: Automatic Buffing Machine Co., Buffalo, N. Y. This is a device for presenting plain cylindrical or other simple work to a wheel mounted on an ordinary buffing head, rotating it and moving it back and forth automatically so as to cover the whole surface. It does this with a uniform pressure, which is said to insure a longer life to the wheel than with hand buffing. It has the further and main advantage of permitting the operator to take care of several machines at once.

Pipe Expanding and Flanging Machine: Lovekin Pipe Expanding and Flanging Machine Co., Philadelphia, Pa. This is a machine which might be likened to a gigantic flue expander. It is intended for pressing steel piping into a tight fit with the flanges, rolling the metal into internal grooves in the latter. This process allows the use of a thinner pipe than is possible where threaded joints are used. The line of machines will handle all sizes from 2 to 24 inches in diameter. Larger machines will be built to special order.

Inserted Blade Boring-Head: George Braithwaite & Oscar B. Elder, Chicopee Falls, Mass. This is a boring-head of the inserted blade type, particularly adapted to finishing cut cored holes preparatory to reaming. The blades are held in place by taper pins, bearing on the bottom sides of elongated slots, thus holding them to their seats in the head. A threaded collar serves to set all the blades forward together, changing the diameter adjustment slightly as may be required. The body of the tool is made of soft material, while the blades are made of high-speed steel.

Bethel Cutting-off Machine: Matson Machine & Tool Co., Bethel, Vt. This is a machine of the friction disk type for cutting off high-speed or other steels. The wheel is 12 inches in diameter by 3/32-inch thick, and should run at about 4,000 revolutions per minute. The machine has the capacity up to 1 1/8-inch round, and will cut flat stock up to 3 inches wide. A special feature of the machine is the fact that the cutting is done at the rear of the wheel, allowing the front to be guarded so as to keep the dust of the cutting operation from the operator's eyes.

Air Hoist: Weir & Craig Mfg. Co., Chicago, Ill. This firm has developed a form of geared air hoist which possesses a number of advantages, chief among them being the small head room required as compared with the plunger and cylinder type of hoist, and the provision made for holding the load at any given point irrespective of leakage. The best of material is used, the gears being cut from hammered steel and the crank being made of forged nickel steel. The bearings are bronze bushed and the machine is built on the interchangeable plan throughout.

All Geared Lathes: Niles-Bement-Pond Co., 111 Broadway, New York City. These lathes have the motor mounted directly on the enclosed headstock casting, and connected with the spindle by guarded gears. The quick change gear mechanism has 32 rates for feeding and thread cutting. This has previously been described and illustrated. (See article entitled "Assembling a 24-inch Engine Lathe" in the November, 1909, issue of MACHINERY, engineering edition). The lathes are built in sizes from 36 to 72 inches, and are furnished either with single pulley drive, or with motor drive.

Portable Electric Drill: Lamb Electric Co., Grand Rapids, Mich. This firm is developing a line of direct and alternating current electrical drills, of which the first size has recently been put on the market. This is a machine capable of drilling ⅜-inch holes in steel, or ½-inch holes in wood. It is provided with a ball thrust, and is furnished with the Jacobs No. 2A chuck. A special feature of the construction is the fact that no ventilating fan is provided, as the motor has been designed to keep cool without requiring a current of air, with the accompanying trouble of chips and dust blowing through the armature.

Sherardizing Equipment: Globe Machine and Stamping Co., Cleveland, Ohio. In the December, 1909, number of MACHINERY we describe an improved drum arrangement, dust hood, etc., for the process of sherardizing or dry zinc plating. The apparatus has been recently improved by the addition of two transfer tables, which permit a continuous movement of the work. This movement is from the loading platform, through the furnace, into the dust hood (where the work is dumped), and back to the loading platform again. This arrangement materially increases the output of a given size of furnace.

Gas Furnaces: Westmacott Gas Furnace Co., Providence, R. I. This firm has recently added three new furnaces to its line. One of these is a quick heating furnace for hardening by the barium-chloride process, obviating the long waits usually required for getting this substance to the hardening temperature. The second furnace is for oil tempering. It is provided with a pot of sufficient size to take a basket of 12 inches in diameter and 14 inches deep. The

third is a lead hardening furnace of rectangular shape, carrying a pot 20 inches long, 10 inches wide and 7 inches deep. It can be furnished either of cast iron or steel.

Double Cold Sawing Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This arrangement consists of two cold sawing machines, one right- and the other left-hand, mounted on a baseplate on which one of the units may be adjusted to give any required distance between the blades, from 1/4 inch up to any reasonable maximum, depending on the length of the baseplate. The use of a double machine of this kind is designed to reduce the idle time of the machine materially, as two cuts can be made at one setting of the work. The machines are of standard design, and belt-driven from the same cone pulley.

Surface and Wet Grinding Machines: Valley City Machine Works, Grand Rapids, Mich. One of this line of tools is a combination surface and tool grinder, comprising a disk wheel of the usual type with suitable work-table at one side of the frame, and an emery wheel at the other with tool-rest and surface grinding platen underneath. The grinding disk is 18 inches in diameter, and the work-table used with it has an angular adjustment. Another member of this line is a combination wet and dry grinder. The wheel for dry grinding is mounted on a heavy hanging arm away from the column, and is provided with a tool-rest.

Ashcroft Valve Grinder, Breast Drill, etc.: Ashcroft Mfg. Co., 85-89 Liberty St., New York City. This device resembles a breast drill in its appearance, but is provided with certain special features adapting it particularly to valve grinding. By the operation of the mechanism provided, the valve is given a rotary motion back and forth, but advancing with each movement a little further to the right, thus bringing it into a new position at each stroke. The surfaces are thus ground to a bearing under the conditions best adapted to prevent scoring, and to give a true seat. It can also be used for a breast drill, or for a right- or left-hand ratchet drill or screw-driver.

Transfer Press: Standard Machinery Co., 7 Beverly St., Providence, R. I. This line of transfer presses is designed on the arch type, and comprises four sizes, ranging from 700 to 4,200 pounds each in weight. As implied in its name, the machine is particularly adapted to double operation work in which the blank is cut out and drawn or simply cut out in the first operation, and then transferred to a second position where it is again drawn, while a new blank is being formed in the first position. It is provided with an adjustable roller feed of improved construction. The transfer mechanism is adjustable to give any stroke from 1 to 3 inches.

Automatic Tapping Machine: Garvin Machine Co., Spring and Varick Sts., New York City. This is a power tapping machine with vertical spindle, having forward and reverse pulleys driven by a single belt. A special feature of the machine is the provision of an automatic reverse for the spindle, set to operate at any required depth of tapping by means of an adjustable stop, and of a friction slip incorporated in the driving clutch. The machine will tap holes from 1/4 to 3/4 inch in diameter in cast iron, to a depth of 1 1/2 inch. The automatic reverse cannot be accidentally thrown out of operation, even by the continued pressure of the operator on the feed lever.

"Oil Drag" Speed Changing Mechanism: Robert E. Newcomb, Holyoke, Mass. In this apparatus a familiar principle, employed in the common multiple disk automobile clutch, has been used to operate as a speed changing device. A series of alternate disks is fastened, one to the driving and the other to the driven member, spaced slightly apart, and submerged in oil. The drag between the driving and driven disks, effected by the oil, is used to permit relative motion between the two members. By means of a piston arrangement the level of the oil in the chamber is raised or lowered, increasing or decreasing the drag, and the speed in proportion.

Four-spindle Cylinder Boring Machine: Moline Tool Co., Moline, Ill. This is a machine of the same general design as others of this line we have previously described. (See, for instance, the multiple spindle drill in last month's department of New Machinery and Tools.) The drive, however, is made unusually heavy, and two spiral gears are provided, allowing the alternate spindle gears to overlap each other so as to permit their being of large diameter, suited to the heavy service required. The spindles are bored for No. 5 Morse taper; the ends will be threaded to fit cutter-heads, or left blank, as required. The machine is back-geared and provided with a double countershaft, giving six changes of speed.

Fuel Oil Crucible Furnace: Alfred Fisher, 103 West Monroe St., Chicago, Ill. This furnace is built in four sizes to hold crucibles from No. 30 to No. 350. The two smaller sizes are equipped with one burner, and the two larger ones with two burners apiece. The fire brick is so arranged as to draw the heat upward and close to the crucible, and also to permit the use of charcoal to prevent oxidization of the charge. As compared with the coal furnace it is intended to replace, it is always ready; it will melt alloys of brass and copper without burning cut the brass borings; and its use results in a saving in fuel and shrinkage. It is stated that it will melt any kind of metal from scrap to sheet zinc, at an operating cost of 6 1/2 cents for 100 pounds.

Rotary Elastic Blow Riveter: Charles Greiner Co., New Haven, Conn. In the December, 1909, number of MACHINERY, we published a note describing a riveting machine in which a series of hammer blows was struck on a spring cushioned hammer by projections on a revolving flange. The hammer was rotated at the same time so as to distribute the action around the head of the rivet and make a symmetrical and thorough job. The present design of this machine is a larger size, and is provided with a vertically adjustable table for accommodating work of various heights. The hammer is brought down to the work by a foot-treadle, which regulates the force of the blow. When the treadle is released the hammer rises, clearing the work automatically.

Rim Friction Clutch: Lehigh Clutch Co., Denckla Building, Philadelphia, Pa. This is a clutch of the type in which the rim of one member is grasped between two or more sets of double jaws on the opposite member. A separate set of toggles is provided for each jaw, drawing the outer ones toward the center and forcing the inner ones outward, gripping the rim between them. Turnbuckles are used to maintain the proper adjustment. The operation is entirely positive, no springs being employed. The friction blocks or wooden shoes can be renewed very expeditiously without dismantling the chuck. The device is made on the interchangeable plan, permitting repairs to be easily effected. Twenty-six sizes are made, of capacities ranging from 4 to 128 horsepower, and in sizes of from 12 to 36 inches diameter.

Squeezer Type Molding Machine: Arcade Mfg. Co., Freeport, Ill. This machine, which is adapted to the use of the double-faced match-plate system of molding, is notable among other things for the convenience provided for the molder. A table for flasks and bottom-boards is mounted on the machine at the left. A support for the riddle is provided at the right, while convenient shelves are mounted on the top of the machine for the parting sand, tools, etc. A gage at the rear of the table serves to locate the flask accurately under the ramming head. The ramming is accomplished by a double-geared toggle device of original design. A vibrator is furnished, operated by a knee pad. The whole machine is mounted on three wheels, so as to always be firmly supported even though the floor be uneven.

Bevel Gear Hobbing Machine: Carpenter-Kerlin Gear & Mch. Co., 77 White St., New York City. This firm has taken the agency for the Chambon gear hobbing machine which is now built by the Société Francaise des Machines-Outils of Paris. This machine was illustrated on page 12 of the September, 1908, number of MACHINERY (engineering edition) where the principles of its operation were fully described. It employs a hob for a cutting tool, and the process of generation is continuous from start to finish, the same as for hobbing spur gears. Owing to the approximate character of the generation, this machine is particularly adapted to roughing out bevel gears which are to be finished by planing. For such work it is very rapid, and cuts closer to the finished shape than any other roughing process hitherto employed.

Plate Planing Machine: William Sellers & Co., Inc., Philadelphia, Pa. This machine for planing the edges of steel plates will take in work 3 inches thick and 24 feet long at one setting. The shape of the housings permits any greater length to be machined by shifting the work as many times as may be required. The carriage is so arranged as to permit its ready removal when necessary, without dismantling the end housings or taking out the driving screw. The feeds are hand controlled, and the tool-holder is turned over by the operator at each end of the stroke. An improved clamping construction makes use of a series of air cylinders. These have the advantage over hydraulic or screw actuated jacks in that they automatically follow up any distortion in the beam due to the pressure gripping the plate from one end to the other equally at a single movement of the operating valve. The machine is intended for heavy duty in planing vanadium steel plates.

Motor-driven Roll Grinding Machine: Norton Grinding Co., Worcester, Mass. It was for a long time supposed that rolls as accurate as those required for paper machinery and similar work could only be successfully ground by the double-wheel calipering process. Modern improvements in grinding machinery, however, have demonstrated that they can be finished accurately in machines similar to the standard plain grinding machines for regular work. In the special roll grinder built by the Norton Grinding Co. the only radical changes made have been in the provision of supports for the neck bearings of the roll (so that they revolve on their own journals in the grinding process) and in the provision of a self-contained motor-drive. Two motors are used, one at the back for driving the wheel, pump and feed, and one mounted directly on the headstock for revolving the roll. A floating device is used for connecting the roll and the headstock faceplate. The

work may be ground on centers as usual, if desired. This machine weighs 18,500 pounds, and will grind rolls from 12 to 22 inches in diameter.

Multiple Spindle Automatic Screw Machine: Davenport Machine Tool Co., New Bedford, Mass. This screw machine incorporates a great number of radical improvements in design for machines of the multiple spindle type. These improvements include separate cam control for each of the five turret tools and the four cross-slide tools; separately adjustable rate of feed for each of the five turret tools and the four cross-slide tools, and individual stops for each of the five spindles and four cross slides, making 20 in all. These individual stops give accuracy in cross-slide operations in spite of irregularities due to the wear of the spindle. The quick-acting, idle movements, such as stock feeding, turret revolving, etc., are performed at the highest rate of speed. Special provision is made for rapid and precise indexing of the spindle head. Other features are wide range of speeds and feeds, single belt drive and removable plate cams for the cutting operations. These various improvements have been applied to a machine capable of taking in ½-inch round rods, feeding up to 2½ inches in length, and turning up to 2 inches in length. The provision of the independent adjustable control for each of the five spindles and four cross-slide tools is especially important in that it permits shortening the time of the longest operation, thus materially increasing the production of the machine over other types not provided with this feature. From the size of the machine it will be seen that it is expected to be used on the finer grades of work, for which the multiple spindle idea has often been considered unsuited.

* * *

APPRENTICESHIP CERTIFICATE

The accompanying halftone shows the apprenticeship certificate granted by the Bantam Anti-Friction Co., Bantam, Conn., to its apprentices when they have completed their full three and one-half years term in its shop. The certificate is

Apprenticeship Certificate issued to Journeymen by the Bantam Anti-Friction Co.

shown about one-third size, its dimensions being about 9 x 11 inches. The company finds that the certificate is an incentive to the completion of the apprenticeship term, and that the boys highly appreciate it. It states that the journeyman to whom issued has received instruction in the operations of lathes, milling machines, drills, tool-making, bench work and other practical shop work. It is signed by the works manager and approved by the president.

* * *

PATENT OFFICE PRACTICE LEGISLATION

The Board of Managers of the Patent Law Association of Washington, D. C., has published a small pamphlet in which objections are made to two bills now pending in Congress relating to certain changes to be made in the tribunals of appeal in the patent office. The passage of these bills apparently would place too much power in the hands of the Commissioner of Patents without any specific benefit being gained. In the place of these two bills the Patent Law Association recommends the provisions contained in the House Bill No. 23,916 recently introduced, which provides that the present courts of appeal in *ex parte* cases shall remain undisturbed, but that appeals in interference cases shall be taken directly from the Examiners-in-Chief to the Court of Appeals of the District of Columbia, and that only in case of a temporary disability of one or more of the members of the Board of Examiners-in-Chief, the Commissioner of Patents may designate a primary examiner to sit temporarily upon the board. This bill removes one of the objectionable features of the former bills which gave the Commissioner power always to designate the three members on the board. As it, of course, does not seem desirable to give to one man the power to designate the members or judges in the appeal cases, it would undoubtedly be to the interest of the efficient conduct of the patent office if the bill approved by the Patent Law Association were passed, and the two previous bills rejected.

* * *

EDISON STORAGE BATTERY STREET CAR

In the March number of MACHINERY some details were given relating to the operation of a street car in New York by the storage battery with which Mr. Thomas A. Edison has been experimenting for a number of years. Some figures were deduced, estimating the size of a storage battery for a street car of the common type, and on account of the weight of the battery for a car of this kind, the opinion was advanced that the additional power required for hauling the dead weight of the battery would likely make the storage battery street car proposition impracticable. Additional information since furnished by Mr. R. H. Beach, 10 Fifth Ave., New York, who is conducting experiments with the Beach street cars using Edison storage batteries, puts the developments in another light.

Mr. Beach found that when the Edison storage battery was applied to an ordinary street car the current consumption was about 125 watts per ton mile. Storage battery operation was out of the question unless the consumption could be reduced. An excellent opportunity to improve the design of the cars, however, offered itself, inasmuch as there has been little improvement in street railway cars during the past twenty years except as regards increasing the size and capacity. Practically nothing had been done to increase the mechanical efficiency of the trucks or the motor. The first important improvement made in the Beach car was the introduction of the differential axle. This device permits the wheels to run independently, and cuts down the current consumption very materially, especially on tracks with many curves. The superstructure of the car was lightened, while the underbody was made as heavy or heavier proportionally than that of standard cars. Instead of chilled cast-iron wheels weighing 500 pounds or more, manganese steel wheels weighing only 125 pounds were used. Instead of a three-to-one gear reduction motor a six-to-one reduction chain drive motor was used, thus reducing motor weight and increasing efficiency of drive. By these and other improvements made in an endeavor to fit the storage battery proposition to street cars a considerable improvement in mechanical efficiency has been brought about, and the current consumption has been cut down to 70 watts per ton-mile, with possibilities remaining for further reduction.

Under these conditions the proposition of using storage batteries assumes a different aspect, although it must also be conceded that if the same improvements are introduced in cars using current from a central station directly, they too will prove much cheaper to run than at present. It should be understood, however, that while the lighter construction can be profitably used for underground conduit system, it could not be used so successfully for trolley systems taking power from an overhead wire, as then a stronger superstructure is necessary to support the trolley and its accompanying mechanism and withstand the racking stresses. Whatever the ultimate outcome of the experiments with storage battery cars, much credit is due to Mr. Beach for inaugurating the improvements in mechanical efficiency and construction which have resulted from his desire to utilize the Edison storage battery.

* * *

Another large ocean liner will soon be built by the Hamburg-American Line at the Vulcan works at Stettin, which will rival, if not exceed in size, the giant White Star liners now under construction. The vessel will be 800 feet long, with a displacement of from 45,000 to 50,000 tons and a speed of 20 knots.

NATIONAL METAL TRADES ASSOCIATION CONVENTION

The twelfth annual convention of the National Metal Trades Association was held at the Hotel Astor, New York, April 13 and 14, with the following official organization: Howard P. Eells, Bucyrus Co., president; J. H. Schwacke, William Sellers & Co., Inc., first vice-president; H. W. Hoyt, Great Lakes Engineering Works, second vice-president; William Lodge, Lodge & Shipley Machine Tool Co., treasurer; Robert Wuest, commissioner. The membership numbers 738, there having been a net gain of twenty during the past year. The association is in a most flourishing condition, and its influence is broadening far beyond the original conception of its charter members. Originally it was almost purely a defensive organization designed to resist the aggressions of union labor, and that work is still its principal function, but now the policy is constructive as well as defensive.

The members generally have recognized the great need for industrial education, and the convention reflected the common desire to promote it in the papers presented. The recognition of the employers' responsibility to workmen worn out in service or disabled was also reflected in papers on old-age pensions and insurance against unemployment. The program of papers following was one of the best ever presented before the association, comprising the subjects of industrial education, compensation of workmen, old-age pensions, liability insurance, shop management, cooperation, etc.:

"The Old-Age Pension Problem and Its Relation to the Industries," by M. W. Alexander.

"The Compensation of Workmen," by H. L. Gantt.

"The Premium System; Some of its Drawbacks," by Carl G. Barth.

"Employers Liability Insurance," by Miles Dawson.

"Modern Method of Shop Management," by Frederick A. Waldron.

"The Fitchburg Plan of Industrial Education," by W. B. Hunter.

"Cincinnati's Continuation School," by Dr. Frank B. Dyer.

"The Necessity for Continuation Schools to Develop Higher Intelligence," by J. Howard Renshaw.

"The Manufacturer's Point of View," by Fred A. Geier.

"The Originator of the School," by B. B. Quillen.

"The Growth of the Cooperative System," by Prof. Herman Schneider.

"Insurance Against Unemployment," by John L. Griffiths.

Prof. W. B. Hunter of the Fitchburg High School, Fitchburg, Mass., described the "Fitchburg Plan" (see MACHINERY, October, 1908, August, 1909, and November, 1909), which is based on the cooperative engineering school and shop work course originated by Prof. Herman Schneider of the University of Cincinnati, and described by him at the N. M. T. A. convention in April, 1908. This plan provides for high school boys what the Cincinnati plan provides for its engineering students.

Dr. Frank B. Dyer, superintendent of schools, Cincinnati, Ohio, described the Cincinnati continuation school work, begun last September. This plan provides for the education of regular apprentices in the Cincinnati shops without loss of time or pay. The school is in session eight hours a day, four and one-half days a week and forty-eight weeks a year. The boys attend one-half day a week and are paid regular wages for the time of attendance. Dr. Dyer said in part:

"Some years ago in Cincinnati we opened night classes for apprentices," said Dr. Dyer. "Pattern making may be taken as an example. We advertised a course for apprentices in every shop in the city. There were fewer than thirty responses. The attendance was irregular and capricious, though the teaching was excellent. Though the courses were continued they did not appeal to those we were wanting. The night school fills a need with older workmen, but the apprentice is a day-time proposition. He must come regularly and through a series of years. The employer must make it worth his while to come, and, in fact, must see that he does come.

"Some of the progressive manufacturers of our city for several years tried to cope with the problem by employing teachers for their apprentices, but such teachers are scarce, and only very large concerns could afford it. The obstacles to the extensive operation of such a plan are too obvious to

Fig. 1. Graduate Apprentice at Work on Milling Machine, Cincinnati Milling Machine Co.

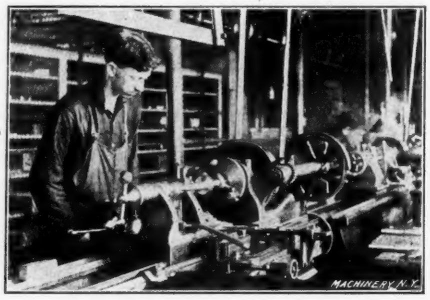


Fig. 2. Apprentice at Work on Engine Lathe, Cincinnati Milling Machine Co.

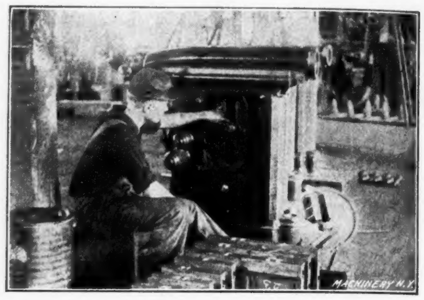


Fig. 3. Apprentice Erecting a Shaper, Steptoe Shaper Co.

Fig. 4. Apprentice at Work on Shaper, Lodge & Shipley Machine Tool Co.

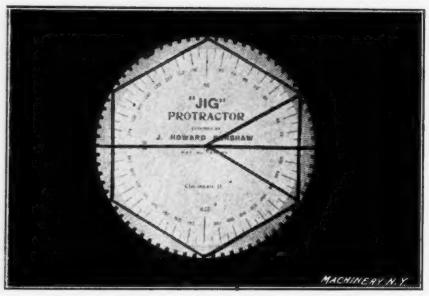


Fig. 5. Renshaw Jig Protractor used in Teaching Geometry

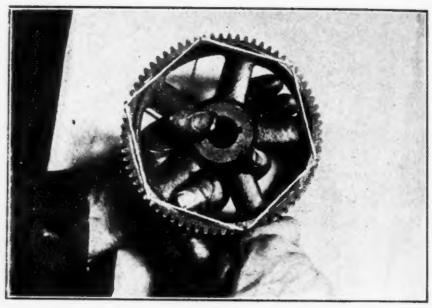


Fig. 6. Application of the Jig Protractor Principle to Gear

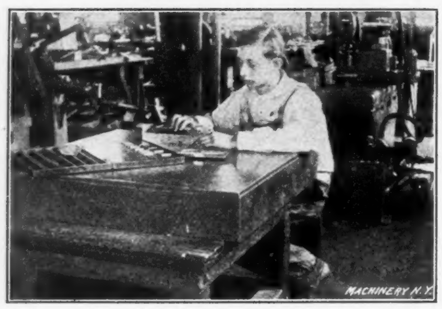


Fig. 7. Apprentice Testing Dovetail Slide with Hardened Plugs and Micrometer

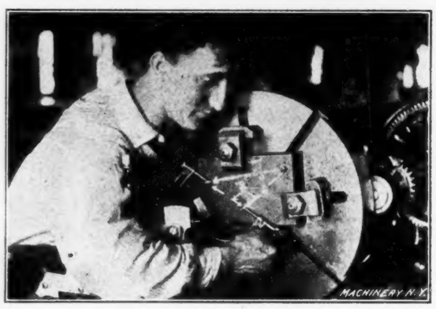


Fig. 8. Apprentice making Practical Application of Trigonometry to Jig Work

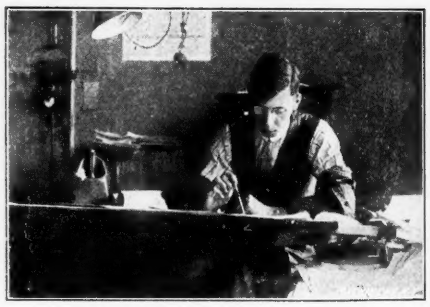


Fig. 9. Draftsman Apprentice, E. Greenwald Co.

need discussion. The only agency that is adequate to cope with the situation is the state, and the state will cooperate when it understands that it is the great industrial class that is to be helped. Employers may have to make some slight sacrifices. They may have to concede to young workmen a little time for their intellectual betterment, but in the end it will be money well spent as an investment. If authority is not given to require employers to send their apprentices to receive the instruction which is the right of every youth, in a democracy at least, it is the privilege of every city to offer an opportunity to such youth in part-time day schools as well as in night schools.

"These ideas ripened in the minds of some of our wisest Cincinnati manufacturers, and thus it came about that the Board of Education of Cincinnati last summer proposed to offer continuation courses for apprentices in any trade, and proceeded to open a school for machine shop apprentices as soon as 150 students were guaranteed. More than 200 students were registered by eighteen manufacturers, and the school started September 1. A man was placed in charge who had been a teacher, a practical shop man, and for many years an instructor of apprentices. He trained his own assistant. The average attendance has been 180 per week. The boys came four hours per week, a new squad coming each half day. The employers pay them for their time, and if they do not show up at school they are reported and docked. The school runs forty-eight weeks a year, eight hours a day, four and a half days a week, and the instructors spend two half days a week, besides, visiting the boys in the shops, talking with the foreman and keeping a line on the needs of the boys. The school is costing the board about $15 a year per boy.

"The course of study is arranged to cover four years. The greatest difficulty was encountered in getting the boys classified correctly and placed in similar groups. While this was gradually accomplished with the assistance of the foremen, it is still necessary to do considerable individual instruction, thus requiring an assistant, though there are but twenty boys in a group. The course taken by the boys is not narrow, nor it is without cultural elements. It includes mathematics, mechanics, drawing, civics, and reading, writing, and spelling. The interesting thing about it is that every study is given a practical coloring, and is made to function in the shop or experience of the boy. The boy sees the purpose of what he is studying, and has a motive in mastering every difficulty. The end of all this is not, as some suppose, simply to send him back next day, able to turn out more and better work; it is to awaken his dormant powers and make him alert, thoughtful, original, and competent.

"These mental exercises relieve him of the monotony of shop routine. As he learns of the great industry in which he is engaged, and of its captains and inventors, and as he discusses its relations with other occupations and with human life, his interest in his work increases, and he comes into sympathy with the great body of the world's workers. As he learns to find new problems in his shop experience, and applies his knowledge to them, his work becomes transformed into a fascinating art. He ceases to be a mere hand, and aspires to be a free master of an honorable craft.

"A great many expert educators from different parts of the world have visited the school and examined carefully into the course and the methods of instruction and have questioned the boys at length. They pronounce the course as one of the most significant efforts yet made to adapt education to vocation, and the method used as representing the most advanced pedagogical views.

"We think so much of the plan in Cincinnati that the Board of Education has offered to open a continuation school for any other classes of apprentices that may be sent, and also for young saleswomen in stores, or girls working in trades. A bill is now before the Ohio State Legislature empowering boards of education to require the attendance of all youth under 16 at part-time continuation schools. If I had the determining of it, there would be a law requiring the attendance of all apprentices through their apprenticeship. Such schools will do much to elevate the standard of work, the degree of intelligence, and the moral character of young workers, and will lift them in the scale of living so that they may be what they should be—the strength of our nation and the envy of the world."

J. Howard Renshaw, the originator of the jig sheet system of mathematical instruction for apprentices, and Dr. Dyer's assistant, illustrated, with a large number of lantern slides, typical apprentice classes sent from the Cincinnati shops, and boys at work (see Figs. 1 to 9, inclusive); also jig sheets used in teaching geometry, trigonometry, analysis of machines, etc.

J. H. Schwacke, of the William Sellers & Co., Inc., was elected president of the association for the coming year; F. C. Caldwell, of the H. W. Caldwell & Son Co., first vice-president; Paul B. Kendig, of the Seneca Falls Mfg. Co., second vice-president; H. P. Eells, of the Bucyrus Co., treasurer. The commissioner is Robert Wuest, New England Building, Cleveland, Ohio.

PERSONALS

F. X. Cleary has been appointed advertising manager of the Western Electric Co., 463 West St., New York.

Harry F. Mesener has been promoted to the position of superintendent of the Grant Automobile Co., Orange, Mass.

W. F. Hittle, who for the past four years has been in charge of the machine department of the Dayton Motor Car Co., has resigned.

B. D. Jackson, for the past five years with Walter H. Foster Co., 50 Church St., New York, is now with the Modern Tool Co., Erie, Pa.

W. C. Wilcox has been appointed manager of the Chicago branch store of the Reeves Pulley Co. to succeed Mr. E. O. Winterowd, resigned.

Louis I. Howard has resigned from a position with the Lamb Knitting Co., Chicopee Falls, Mass., to become manager and treasurer of the National Scale Co. of the same city.

Walter M. McFarland, acting vice-president of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has resigned to take an official position with the Babcock-Wilcox Co., New York.

H. C. Fay, foreman of the chucking, punching and shaving department of the Remington Arms Co., Ilion, N. Y., has been appointed to succeed Mr. A. C. Brown in the tool and gage department.

Henry T. Merriam, manager and engineer of the R. F. Hawkins Iron Works, Springfield, Mass., has resigned the position to assume the management of the Grip Coupling Co., Ware, Mass.

Matthew Harrison has resigned the position of superintendent of the Grout Automobile Co., Orange, Mass., to become assistant superintendent of the Stevens-Duryea Automobile Co. at Chicopee Falls, Mass.

George E. Tiffany, foreman of the drop forge and die sinking department of the Remington Arms Co., Ilion, N. Y., will assume charge of the chucking, punching and shaving department, succeeding Mr. H. C. Fay.

Benjamin K. Hough has been appointed Boston sales manager of the Wisconsin Engine Co., Corliss, Wis., with offices in the Oliver Building, Boston. Mr. Hough will represent the company in the New England states.

E. G. Matter, who has been with the National-Acme Mfg. Co., Cleveland, Ohio, in the Ohio and Chicago territory for the past five years, has been put in charge of the newly-opened Detroit office at 1222 Majestic Building.

C. A. Nourse, for the past three years with the Alden Sampson Mfg. Company, Pittsfield, Mass., as superintendent, has resigned to take a position with the American La France Fire Engine Co., Elmira, N. Y., as machine shop foreman.

Alfred C. Brown, for the past four and one-half years foreman of the tool and gage department of the Remington Arms Co., Ilion, N. Y., has resigned to take a position as superintendent with the Denver Rock Drill & Machinery Co., Denver, Col.

George S. Perkins, Springfield, Mass., who for the past four years has been draftsman for the Fisk Rubber Co., Chicopee Falls, Mass., designing molds and special machinery, has resigned to take a position in the drafting department of the Confectioners' Machinery & Mfg. Co., Springfield, Mass.

J. A. Brown, who has been employed in the ordnance department as mechanical engineer and as chief draftsman, and for the past five years as constructing engineer, at the Frankford Arsenal, Frankford, Pa., has resigned to engage in private practice. Mr. Brown will also represent several well-known manufacturers of machine shop equipment.

Morgan K. Barnum, who was recently appointed superintendent of motive power, for the Illinois Central R. R., is a graduate of Syracuse University. He began his railway career as a machinist apprentice with the Erie R. R. Mr. Barnum will have charge of the entire mechanical department of the Illinois Central R. R.

F. Mueller, partner of A. Engelman & Cie, Liège, Belgium, is in the United States on a business trip. He will call upon manufacturers of machine tools and accessories in order to learn of new inventions and improvements and to make contracts for representation abroad. His address while in the United States will be the Waldorf-Astoria Hotel, New York.

Jonah E. Titus, an employe of the New Home Sewing Machine Co., Orange, Mass., for forty-three years, over thirty-five of which were spent as foreman, recently resigned on account of continued ill health, his resignation to take effect on his sixty-fifth birthday. Mr. Titus had more men under his supervision than any other department foreman in the building.

James Cordner has resigned the position of general foreman at the Stevens-Duryea automobile factory, Chicopee Falls, Mass., to become general foreman of the Locomobile Co. in Bridgeport, Conn. Mr. Cordner was tendered a farewell banquet at the Haynes Hotel, Springfield, by about sixty-five of his associates and was presented with a full jewelled gold watch suitably engraved.

The personal in the March number of MACHINERY stating that Frank A. Foster had sailed to China as representative of the American Locomotive Co. in Tientsin was erroneous as regards his connection with that company. Mr. Foster held a position with the American Locomotive Co. in Providence, R. I., but went to China to take another position in which he will have considerable to do with the machinery and mechanical part of railway work.

Charles H. Norton of the Norton Grinding Co. was recently elected president of the Worcester Mechanics Association, Worcester, Mass. For several years Mr. Norton has been prominent in this association, which was formed about the middle of the last century by those interested in mechanical trades as a means of mutual improvement. This association owns its own building, library, etc., and by means of its activities has done much to develop the industries of Worcester.

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OBITUARIES

Eugene Stuart Bristol, president of the New Haven Mfg. Co., New Haven, Conn,. died April 2, in his sixty-seventh year.

David A. Jones died at Springfield, Mass., April 4, aged eighty-five. Mr. Jones had been employed by the United States Government for more than fifty years, working at Windsor, Vt., and Springfield, Mass. He gave up work at the United States Armory at Springfield, Mass., about a year and a half ago.

Lucien F. Bruce, for more than fifty years an employe of the United States Armory, Springfield, Mass., died at his home March 13, aged seventy-six years. Mr. Bruce had been assistant foreman, and was the inventor of many improvements on guns and machinery for making them, the most important of which was a mechanism for feeding cartridges in the Gatling gun. He was an expert engraver on metal. Mr. Bruce had charge of the government armory exhibit at the Centennial Exposition at Philadelphia, Pa., in 1876.

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COMING EVENTS

May 4-5.—Annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria St., London.

May 10-13.—Seventeenth annual convention of the Air Brake Association, Indianapolis, Ind., Dennisson Hotel, headquarters. An interesting program has been prepared on air brake construction, air pumping, piping inspection and cleaning, triple valves and brake cylinders, recommended practice, etc. F. M. Nellis, secretary, 53 State St., Boston, Mass.

May 11-13.—Joint convention of the American Supply and Machinery Manufacturers' Association and the National Supply and Machinery Dealers' Association at Atlantic City, N. J. F. D. Mitchell, 309 Broadway, New York, secretary-treasurer, American Supply and Machinery Manufacturers' Association.

May 16-18.—Fifteenth annual convention of the National Association of Manufacturers, Waldorf-Astoria Hotel, New York. George S. Budinot, secretary, 170 Broadway, New York.

May 24-25.—Spring convention of the National Machine Tool Builders' Association at Rochester, N. Y., Hotel Seneca, headquarters. Charles E. Hildreth, secretary, Worcester, Mass.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-4.—Second annual state convention of Pennsylvania engineers, for the furtherance of the organization of the Engineers Society of Pennsylvania, Hall of Representatives, Harrisburg, Pa. Engineers Society of Pennsylvania, Gilbert Building, Harrisburg, Pa.

June 6-10.—Convention and exhibition of the Foundry and Manufacturers' Supply Association, Detroit, Mich. C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 15-17.—Annual convention Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-22.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-July 6.—Detroit Industrial Exposition, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building is being erected to be used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

August 16-19.—Annual convention of Traveling Engineers Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

NEW BOOKS AND PAMPHLETS

THE BELOIT COLLEGE BULLETIN. Catalogue for 1909-1910. 152 pages, 5½ x 7½ inches. Published by the Beloit College, Beloit, Wis.

COLUMBIA UNIVERSITY BULLETIN OF INFORMATION. Announcements of summer sessions, 1910. 90 pages, 6 x 9 inches. Published by the Columbia University, New York City.

THE WEATHERING OF COAL. By S. W. Parr and W. F. Wheeler. Bulletin No. 38. 43 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

BULLETIN OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. Announcements of summer courses, 1910. 20 pages, 6 x 9 inches. Published by the Massachusetts Institute of Technology, Boston, Mass.

BULLETIN OF THE UNIVERSITY OF NEW MEXICO. Catalogue for 1909-1910, and announcements for 1910-1911. 136 pages, 5½ x 7½ inches. Published by the University of New Mexico, Albuquerque, New Mexico.

UNIT COAL AND THE COMPOSITION OF COAL ASH. By S. W. Parr and W. F. Wheeler. Bulletin No. 37. 67 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

THE PENNSYLVANIA RAILROAD AND THE FARMER. The Creating of Traffic through the Cooperation of Farmer and Railroad. 14 pages, 5½ x 7½ inches. Published by the Pennsylvania Railroad, Philadelphia, Pa.

BULLETINS OF REVENUES AND EXPENSES OF STEAM ROADS IN THE UNITED STATES. Nos. 8, 9, 10 and 11, covering the months September-December, 1909. Prepared by the Bureau of Statistics and Accounts, and published by the Interstate Commerce Commission, Washington, D. C.

ENGINEERING INDEX ANNUAL. 471 pages, 6½ x 9½ inches. Published by the *Engineering Magazine*, New York and London. Price, $2.

This well-known publication fills an established place in the reference library of the engineer. It is compiled from the monthly indexes of periodical literature in the *Engineering Magazine*, and gives the title, a brief statement of the contents of the article, the approximate number of words in the article, and the name and date of the publication in which it appeared. The subjects covered include civil, electrical and mechanical engineering, mining and metallurgy, railway engineering, marine and naval engineering, street and electric railways, and industrial economy. The usefulness of the new and simpler method of classification adopted has been proved by the extraordinary demand for last year's annual as compared with that of previous years.

ENGINEERING THERMODYNAMICS. By C. F. Hirschfeld. 157 pages, 3¾ x 6 inches. 22 illustrations. Published by the D. Van Nostrand Co., New York City. Price $0.50.

This book, which is now in its second revised edition, is one of the numbers in the Van Nostrand science series. The author, who is assistant professor of power engineering at the Cornell University, has treated the important subject of thermodynamics as applied to engineering in nine short and concise chapters on Heat, Gases, Entropy, Cycles, Flow of Gases, Vapors, Expansions and Compressions of Vapors, Vapor Cycles, and Flow of Vapor. The science of thermodynamics is based upon a few fundamental principles. The difficulties met with in the study of thermodynamics are usually due to the fact that the average student in his first attempts to obtain a working knowledge of this science fails to thoroughly observe and fix these fundamental principles in his mind, and build up a superstructure on this basis. In the present book the author has presented the subject in such a manner that the underlying principles may be clearly recognized. The study of this book will enable the engineering student to more easily follow the generalized and complicated cases considered in larger standard works on the same subject.

PRACTICE AND THEORY OF THE INJECTOR. By Strickland L. Kneass. 175 pages, 6 x 9 inches. 53 illustrations. Published by John Wiley & Sons, New York City. Price, $1.50.

This book, now in its third revised edition, has been prepared with a view of presenting solutions of some of the more interesting problems met with in injector practice, and of describing in detail the functions of the different parts. Complex formulas have been avoided in the mathematical discussion; the treatment, in general, is direct and simple, and is based on carefully conducted laboratory tests. The third edition has been improved by including an additional chapter on the requirements of modern railroad practice. This chapter has been made necessary by the marked changes in the construction of locomotives during the last few years, which changes have reacted upon the method of feeding boilers and upon the injector design. The book treats of the early history of the injector and its development and describes the important parts of the device; detailed attention is then given to the delivery tube, the combining tube and the steam nozzle, and complete reference is made to the action of the injector. One chapter is devoted to the application of the injector in American and foreign practice, and another to the determination of sizes, based upon practical tests. The methods of feeding locomotive boilers, as already mentioned, have been touched upon, and the subjects of feed water heating, efficient feeding, scale-bearing water, check valves, etc., have been given some attention. Owing to the lack of books upon this subject which have been based directly upon experimental research, this book should be of especial interest to steam engineers who are interested in the practice and theory of injectors.

APPLIED MECHANICS. By David Allan Low. 551 pages, 5½ x 8½ inches. 850 illustrations. Published by Longmans, Green & Co., London and New York. Price, $2.75.

This book includes a treatise on the strength and elasticity of materials, the theory and design of structures, the theory of machines and hydraulics, and is especially intended as a text-book for engineering students. The author, who is professor of engineering at the East London College of the University of London, England, has given particular attention to the matter of exercises, of which not less than 780 are given, 600 of them being original. The remaining 180 exercises have been selected with great care from the examination papers of various examining bodies. The answers to these exercises are given at the end of the book and will be useful to students who study at home without the aid of a teacher. The subject matter is as clear and concise as is possible in a work of this kind, and covers a wide field. It pre-supposes, however, a considerable knowledge of mathematics, as calculus is freely used in the demonstrations and examples whenever necessary. The scope of the work is best indicated by a general review of the contents. The book opens with a preliminary chapter reviewing the most fundamental mathematical formulas, then deals with motion, force, work and energy, the polygon of forces, moments, stresses, beams and bending; the deflection of beams, columns and struts; testing materials, stress diagrams, design of roofs, plate girders, braced girders, etc.; acceleration, velocity diagrams, piston and crank effort diagrams, governors, brakes and dynamometers; belt, rope and chain drives; gearing and balancing. Several miscellaneous mechanisms are also treated in a chapter by themselves, and considerable attention has also been given to friction and lubrication. The book is concluded with five chapters on hydrostatics, hydraulics, water wheels, turbines, pumps, and some other hydraulic pressure machines. On account of its highly technical nature and its exceedingly thorough treatment of the subjects involved, it is recommended rather to the student who wants to make a thorough and fundamental study of the subjects than to persons who would use it merely for occasional reference.